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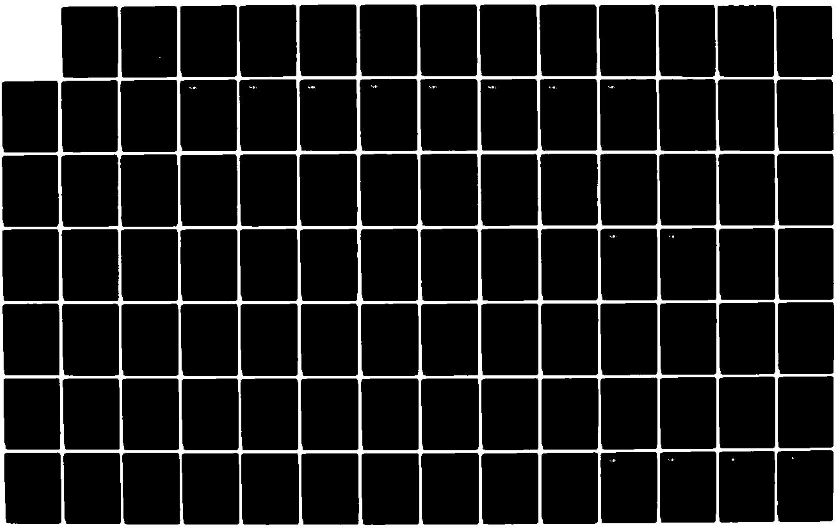

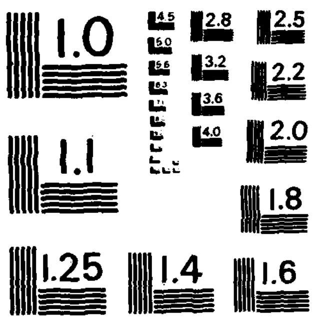
1.0
4.5
5.0
5.6
6.3
2.8
3.2
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2.0
1.1
1.8
1.25
1.4
1.6

(4)

NAVY PIER CONCEPTS
REPORT NO. 2/84

FINGER PIER / SPINE PIER CONNECTION FOR THE EXPEDITIONARY PIER

SUBMITTED TO:

DEPARTMENT OF THE NAVY

OFFICE OF NAVAL RESEARCH
ARLINGTON, VIRGINIA

SUBMITTED BY:

T.Y. LIN INTERNATIONAL

APRIL 1984

4

FINGER PIER/SPINE PIER CONNECTION
FOR THE EXPEDITIONARY PIER

List of Figures

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 2/84	2. GOVT ACCESSION NO. AD-A146144	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) FINGER PIER/SPINE PIER CONNECTION FOR THE EXPEDITIONARY PIER		5. TYPE OF REPORT & PERIOD COVERED Technical
		6. PERFORMING ORG. REPORT NUMBER 2/84
7. AUTHOR(s) T. Y. Lin International		8. CONTRACT OR GRANT NUMBER(s) N00014-83-C-0869
9. PERFORMING ORGANIZATION NAME AND ADDRESS T. Y. Lin International 315 Bay Street San Francisco, Calif. 94133		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS NR 294-083
11. CONTROLLING OFFICE NAME AND ADDRESS Office of Naval Research 800 N. Quincy Street Arlington, VA 22217		12. REPORT DATE April 1984
		13. NUMBER OF PAGES 91
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

1. Pier Design
2. Pier Connections
3. Floating Pier Motions

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A critical component of the floating expeditionary pier concept is the connection between the finger piers and the main body or spine. This report provides an assessment of the present design capabilities for such a structure. Shock absorbing system and hinge pin design are identified as particularly difficult design problems.

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FINGER PIER/SPINE PIER CONNECTION FOR THE EXPEDITIONARY PIER

1. INTRODUCTION

The connection between the finger pier and the spine pier in the expeditionary pier concept was selected for further development in the current contract year with the Office of Naval Research, mainly because it represents one of the more serious technological obstacles that had to be overcome before the expeditionary pier could become a reality in the form it was originally concieved. To recap, the expeditionary pier that provides berthing facilities to 6 combatant ships of the destroyer class has the shape of an arrow on plan, and moored by a single-point mooring, partly to reduce wave and current forces to a minimum. The finger piers form the extensions to the arrow head, attached at about 45 degrees with the axis of the spine pier by means of a connecting structure, which is the subject of this report (referred to as the finger/spine hinge joint in previous reports). During tow, the finger piers are retracted and stowed alongside the spine pier. The general arrangement showing the relationship between the finger pier and the spine pier is presented in Figure 1.

As indicated above, the purpose of this report is to test the feasibility of the retractable finger pier concept, and to assess the technological gap, if any, that separates it from the state of the art. The undertaking proved to be more formidable than expected. However, enough had been accomplished within the limited time for the study to understand the problem better, and to produce a set of reasonable figures for the preliminary design of the connection.

2. DESIGN CONSIDERATIONS

In order to quantify the forces that can be used in the design of the connection structure, it is first necessary to establish the conditions for which the connection is to be designed. In fact, there is only one such condition that needs to be considered for the purpose of this report; namely, the environment conditions under which the finger piers will operate. There are other conditions, but they are not expected to be of significant magnitude to influence the outcome of the order-of-magnitude assessment, and may be disregarded to simplify the procedure.

Since the finger pier will be in operation only when the expeditionary pier is safely anchored in sheltered waters, it is reasonable to assume that the connection structure will not be subjected to environmental conditions more severe than Sea State 4. This, therefore, has been assumed as the basis for the connection design.

3. THE ABBREVIATED ANALYTICAL SOLUTION

It is recognized at the outset that an in-depth analysis of the connection with its multiple degree of movement under exciting conditions that can emanate from a dozen sources would be an extremely complex, exacting and time-consuming exercise. An abbreviated, or a short-cut solution must be found that will produce reasonable answers within the available time. As explained below, the abbreviated method consists simply of considering the most significant factors in the analysis, ignoring the rest, and of making broad assumptions on boundary conditions that are not unreasonable for the purpose of getting some quick answers.

The abbreviated method was partly based on the following observations about the connecting elements (links and shear key), see Figures 2 and 3.

a. The system is extremely rigid in restraining horizontal movements, huge forces will be developed in the elements as a consequence to inhibiting the pier against wave induced motion.

b. The relative size difference between the finger pier and the spine pier is such that the analysis could justifiably be simplified by considering the finger pier to be connected to a fixed rather than another floating body. This assumption presupposes that the effect due to phase differences in the motion of the finger and the spine piers will be small and can be neglected in this evaluation. An analytical model has been constructed on this basis. If a more exact analysis is required, the above mentioned behavior can be determined by modelling the finger and the spine piers together and then obtain a time history of motions for the desired sea state. It is also observed that the forces due to wind current and wave drift should be more or less constant, much lower than the transient wave forces induced by the vehicle motion.

Based on the above observations and assumptions, an appropriate model and approach were developed. The approach is to determine the free floating equations of motion (dynamic matrix, and displacement and force vectors), and then by including the stiffness of the connection system in the free-floating dynamic matrix, solve the equations of motion for displacements. The forces in the connection elements are calculated based on the determined displacements.

The analysis began with determining the free floating motions of the finger pier for various sea headings. The connection elements are so configured that they resist forces in the horizontal plane, tension in the links is expected to be caused mainly by yaw moments. Forces due to surge will not be as significant because of the small beam of the pier relative to its length. Additional forces will be caused by pitching of the finger pier relative to the spine pier. These forces could be controlled to a great extent by narrowing the contact depth between the 2 piers.

Strip theory was used to compute the free floating motions of the pier, modelled as a stationary vessel, and a Sea State 4 spectrum having 6 feet significant wave height, and mean period of 5.5 seconds. Figure 1-A (Appendix A) illustrates the analytical model description.

A description of the mathematical model of the connection structure is shown in Figure B-1 (Appendix B). The model assumes that all vertical motions at the connection interface are unconstrained for pitch and heave motions. The connector, or link, is designed to resist forces generated by yaw, surge, and pitch, and the shear key is designed to resist forces due to sway.

Tolerance at shear key interface and the hinges in the links will provide the freedom of movement in the vertical direction.

A detailed explanation of the analytical model and its limitations are given in greater details in the Appendeses following this report.

4. DISCUSSION OF RESULTS

The magnitude of the free floating motions for various headings can indicate the critical loading conditions for the connection elements. A wave heading of 110° (from the longitudinal axis) was found to produce the maximum motions for the imposed irregular sea. Hence, further analysis was done only for the above wave heading.

The drift forces due to wind, current and wave drift were added to the calculated transient forces. The forces in the links were determined to be in the order of 6,000 kips tension, or a reversible tension and compression of 5,000 kips based on the system design. The force in the shear key was found to be 1,300 kips.

If the links are absolutely rigid, a tension-compression couple of 5,000 kips is developed in the links in order to resist the yaw moments. It is structurally undesireable to develop compression in a slender member such as the link. The compression could be eliminated if the link was allowed to displace when in compression and the finger pier could contact (or bear against) the spine pier. This effect somewhat shortens the couple arm resisting the yaw moments, the tension is estimated to be 6,000 kips and the compression component of the couple is provided by the bearing stresses developed by the contact of the two piers.

The analysis showed considerable heave (5 ft. relative to spine pier) and pitch displacements. In order to keep the link forces low and to conform with the assumptions of the analytical model, the heave and pitch displacements should be allowed. For instance, considering a total length of 30 ft. for the link, a 5 ft. vertical displacement requires an axial extension of about 5 inches in the link.

The preceding discussion indicates that the link should have a "shock absorbing" ability or in other words an "extendable" link is desired. For design purposes, the object will be to provide an axial extension of up to 18 inches before the load capacity of the system is exceeded. A proposed design for an "extendable" link is discussed in the following section.

The shape and dimensions of the finger pier may be altered to ensure efficient behavior. The effects of pitching can be minimized by reducing the depth of the contact area of the finger and spine piers. See Figure 6. The forces in the links can be reduced by increasing the distance between the two links. The effect of the forces in the links for a particular value of yaw moment, versus the distance is illustrated in Figure 8.

5. THE CONNECTING SYSTEM

An obvious first solution is represented by the pinned joint used by the offshore industry to connect the "Stinger" to the barge in the pipe-laying operation. The difference is however the magnitude of the forces that the joint has to deal with. For the stinger-type connection, the pin would have to be much larger and heavier, making connection in the relatively open sea difficult. It is also not possible for the finger pier to be swung around a pinned joint, with the pin aligned in the horizontal direction. If this method of connection is used, it will be necessary to disengage the connection completely when the finger pier is not in use, and to attach it to the spine pier by other means.

The following considerations therefore govern the design.

a. A system that lends itself to rapid installation and disengagement. This means the system should preferably be located on top of the deck for easy access, control and operation.

b. A system that provides restraint in the horizontal direction, but relative freedom of movement in the vertical direction.

c. A system that incorporates "shock-absorbing" capabilities to reduce the huge forces generated by pier motions, and thereby bringing the design of the connection closer to the state of the art.

The design that had resulted from the above described constraints and considerations is shown in Figure 4. The member has a length of about 30 feet. There are two hinges at each end (labeled as horizontal hinge and vertical hinge), that provide vertical and horizontal rotational freedom. To avoid any moments on the vertical hinge due to inclined loads on the horizontal hinge, the "frame leaf" or the stationary part of the horizontal hinge is restrained by an anchor which is free to slide in a circular guide track. By an appropriate alignment of the two hinges (as shown in Figure 4), it is assumed that the vertical component of the inclined load will be taken by the "sliding anchor" and the horizontal component will be uniformly distributed over the height of the vertical hinge.

Another unusual feature of the link is the hydraulic tension "shock-absorber". A shock-absorber to meet our requirements, such as a capacity of 6,000 kips, stroke of 12" to 18", and a smaller compressive stiffness compared to a tensile stiffness is not readily available but can be specially fabricated. If a single shock absorber is used, the cylinder size is estimated to be 32 inches O.D. and ultra high strength, aircraft quality materials would have to be used. A survey of the industry, indicates that a 32 inch shock-absorber can be fabricated within the state-of-the-art technology with some upgrading of existing manufacturing facilities. Another approach could be to use a cluster of two smaller shock-absorbers in parallel. Details of a proposed design by Taylor Devices Inc., New York, are shown in Figure 4-a.

The amount of steel estimated for each link is about 88 tons. The member

was designed using stress levels recommended by the American Welding Society code (AWS code). Grade 36 steel can be used for the members, but ultra-high strength steel, having higher stress levels than the AWS code recommended values, has to be used for the hinge pins in order to obtain practical dimensions. A total cost of $360,000 is estimated for each link. This price includes the cost of the hydraulic shock-absorber which is about $100,000.

6. ALTERNATIVE SOLUTION

The finger pier must be modified to better cope with the large forces, particularly the force generated by yaw moments on the two-point link connection. Having identified this as the prime force generator, one method to deal with it would be to spread the distance between the two connection points as much as possible. Thus if it is possible to increase this distance by 100%, the effect would be to reduce the yaw-induced force in the links by half. One might also taper the plan shape of the finger pier to that of perhaps half its present width of 80 feet, toward the end of the pier. The advantage of this modification is to bring the centre of gravity of the pier closer to the connection, thereby reducing the effects due to rotational forces.

Displacements at deck level due to pitching can be reduced by narrowing the depth of the contact area between the spine and finger piers. For a particular pitching angle the displacement at the deck level is directly proportional to the distance to the point of "pivoting".

The widening of the contact face at the connection, and the tapering of the pier have been combined in an alternative system shown in Figure 5. A proposed longitudinal section for the finger pier is shown in Figure 6. These modifications would be the first direct result of the further development of the retractable finger pier as described in this report.

7. PROBLEM AREAS

The design of the connection is generally within the state of the art. It would however take considerable time and effort to develop this concept to the application stage.

The biggest problem area is due to the escalation of scale as represented by the exceedingly large forces that must safely be handled by the connecting link structure, the shock-absorbing capacity, and the articulating mechanism in the connection system. The analysis part should therefore present the least problem. There is no shortage of computer software capable of solving dynamic problems connected with the pier. The program OSCAR has been used here only because it was readily available.

The problem pertaining to the design has to do with the development of equipment, particularly the hydraulic shock-absorbers. The fabrication of a large (32"O.D.) shock-absorber is not feasible within the present state of the art. The major portion of the total cost (100,000) of each shock absorber, is the cost of special high-strength, corrosion resistant materials. Further research may be feasible to develop more economical materials for our application.

It was felt that practical dimensions for the hinge pins could not be obtained by using the available design guidelines for fatigue loadings. The only way to obtain a reasonable design is to use ultra-high strength steel, with higher allowable fatigue stresses.

Figures 6 and 4 illustrate some rather unusual features of the connecting system. The proposed rub-strips and fenders at the interface of the finger and spine piers perform unusual functions and require to be developed. The

rub-strips need to have a low coefficient of friction, and at the same time durable enough to justify its use and cost. The design of the sliding anchor will also be complex. It is required to provide constraint in the vertical plane but is relatively free in the horizontal plane.

We would also require auxiliary equipment for extending and retracting the pier, e.g. large capacity winches with which to move the pier. These are not so unusual that they are not already available commercially.

8. CONCLUDING REMARKS

In the generic sense, the flexible connecting system as envisaged in this study, may be adapted to other purposes. For example, they could be used to join several barge-like vessels to form:

a. Floating roadway to offshore installations.
b. Floating platform for offshore installations.
c. Floating breakwater for offshore habour.

These possibilities are shown in Figure 7.

The constraint of time is particularly telling in a heavily analytical undertaking such as this report. Unlike some of the previous efforts, this report cannot therefore lay claim to any development or discovery of significance. It does however contribute to a better understanding of the problem connected with the hitching of the pier, therefore representing another step toward building up the technology for the retractable finger pier.

APPENDIX A

FREE FLOATING BEHAVIOR

Appendix A: FREE FLOATING BEHAVIOR

In order to determine the critical, wave loading conditions for the finger/ spine joint, free floating response amplitude operators were calculated for sea headings of 180°, 160°, 135°, 110° and 100°. Motions were also calculated for a sea spectrum with a significant height of 6 ft. and mean period of 5.5 seconds. Fig. A-1 illustrated the orientation of the heading angles.

Strip theory was used to estimate the vessel motions, the pier was divided into thirty-two stations (strips), the distribution of the stations over the length is shown in Fig. 1-A. The pier was modelled as a free floating stationary vessel.

The response amplitude operators, and the statistics of motion for the specified sea spectrum are included in Pages A-8 to A-17. The response reported in the outputs is for the local origin specified for the mathematical model (see Fig. A-1). Or, the motions represent the displacements of the joint end of the finger pier.

It is seen that a wave heading of 110° is most severe for the imposed sea spectrum, except for sway and roll motions which are greater for a heading of 100°. (See p. A-6)

A computer program, Ocean Systems Computer Analysis Routines (OSCAR), compiled by Ultramarine Inc., of Houston, Texas was used for the free floating analysis.

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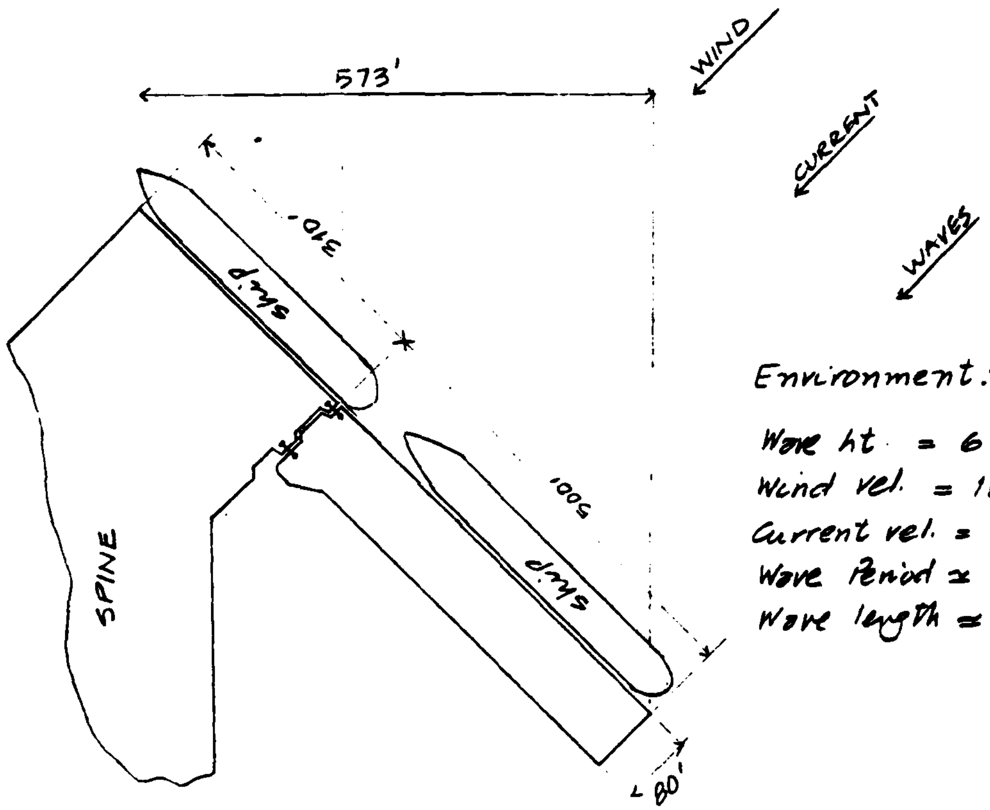
315 Bay St., San Francisco, Ca. 94133

PROJECT:	Navy Pier Concepts
ITEM:	Finger / spine connection
DESIGN:	Forces (Prelim.)
DATE:	2/84 HN

SHEET: A-2
OF ____
REVISION:

Forces on Spine / finger joint. Most severe loading condition. @ service mode.



Environment:

Wave ht = 6'
Wind vel. = 18 knots
Current vel. = 1 knot
Wave Period ≈ 5.5 sec
Wave length ≈ 150'

Calculate forces on joint:

Wind: (@ 18 knots or 30.4 F/s)

Assume 1 DD--- type ship is berthed against finger pier
Appx. draft = 35' and projected surface area = 25000 FT²; L = 500 FT.

$F_W = \frac{1}{2} \rho C A_p V^2$

$F_W = \frac{1}{2} \times 0.00237 \times 1 \times 25000 \times 30.4^2$

$F_W = 30$ Kips acting at 333 FT from joint

Surge:

$F_S \simeq 0.33 F_W = 10$ kips

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ITEM:	Finger / spine conn.
DESIGN:	Forces (Prelim)
DATE:	2/84 HN

SHEET: A-3
OF
REVISION:

Current: (@ 1 knot or 1.69 F/s)

$F_{CD} = \frac{1}{2} \rho C_D A V^2$

$F_{CD} = \frac{1}{2} \times 1.99 \times 1.2 \times 500 \times 35 \times 1.69^2$

$F_{CD} = 60$ Kips

$F_{CS} = \frac{1}{2} \rho C_S A_S V^2$ $\qquad C_S = 0.01$

$F_{CS} = \frac{1}{2} \times 1.99 \times 0.01 \times 40000 \times 1.69^2$ $\qquad A_S \simeq 40000\ FT^2$

$F_{CS} = 2$ Kips.

Wave Forces: ($h = 6'$, $L \simeq 150'$, $T = 5.5\ s$)

- For conservative estimate use Sainflou's Formula (DM 26-2-16)

Assume water depth of 80 FT.

$\therefore \frac{d}{L} = \frac{80}{150} = 0.5$

From DM 26 Fig 2-14

$P = 2.8$ lbs / FT² acting on broadside

$\therefore F_{wave} = 2.8 \times 35 \times 500 = \underline{49 \text{ Kips}}$.

$\therefore$ Total lateral force on Finger pier

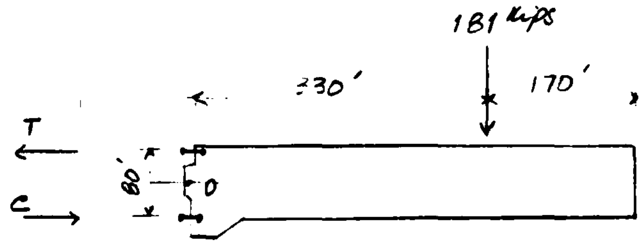
$F = 30 + 10 + 62 + 49 = 181$ Kips.

acting @ 330 FT from joint.

$\Sigma M@0 = 0$

$181 \times 330 = T \times 80$

$\Rightarrow T = 746^K = C$



OR if compression is provided by finger pier bearing against spine pier, say moment arm is 60 Ft.

$\therefore T = \frac{181 \times 330}{60} = 1000^K$.

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PROJECT:	ONR, Navy Pier Concepts
ITEM:	Finger/Spine Connection
DESIGN:	Finger Pier water plane props.
DATE:	2/84 HN
SHEET:	A-4
OF:	
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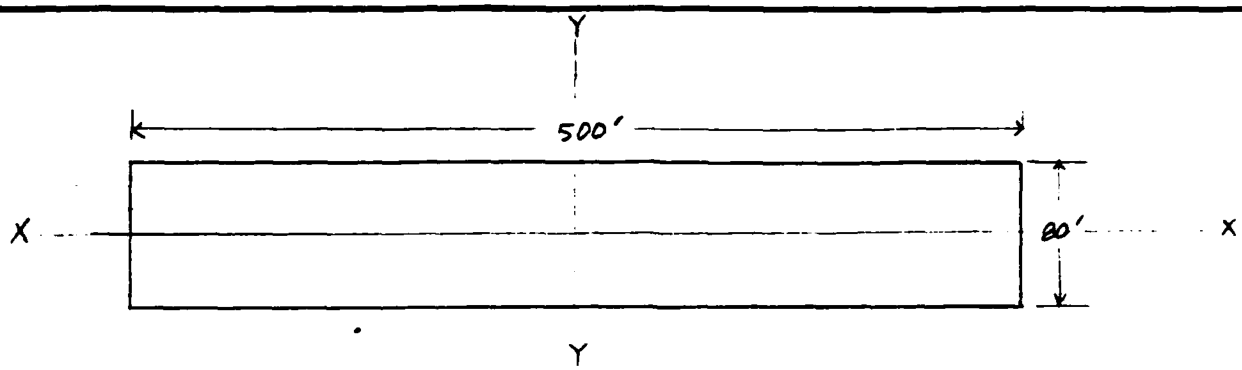
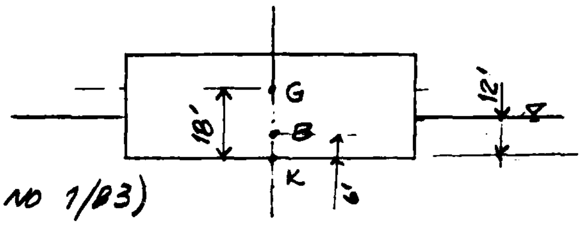


Plan

$A_P = 40000 \ FT^2$

$I_{XX} = 21.33 \times 10^6 \ FT^4$

$I_{YY} = 833.33 \times 10^6 \ FT^4$



$KG = 18 \ FT$ (P. A-27 Report No 1/83)

$KB = 6 \ FT.$

Transverse metacenter:

$$GM_T = \frac{21.33 \times 10^6}{(40{,}000 \times 12)} - (18 - 6) = 32.4 \ FT.$$

$$r_x \simeq \left(\frac{21.33 \times 10^6}{40{,}000}\right)^{1/2} = 23.1 \ FT \Rightarrow T_r = \frac{1.108\, r_x}{\sqrt{GM_T}} = 4.5 \ sec$$

Longitudinal metacenter;

$$GM_L = \frac{833.33 \times 10^6}{(40000 \times 12)} - (18 - 6) = 1720 \ FT.$$

$$r_Y \simeq \left(\frac{833.33 \times 10^6}{40000}\right)^{1/2} = 144 \ FT \Rightarrow T_L = \frac{1.108\, r_Y}{\sqrt{GM_L}} = 3.8 \ sec$$

For typical barge type vessels:

$R_{ROLL} = 0.32 B = 25.6 \ FT.$

$R_{PITCH} = 0.29 L = 145. \ FT.$

$R_{YAW} = 0.29 L = 145 \ FT.$

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PROJECT:	ONR, Navy Pier Concepts
ITEM:	Finger/spine conn.
DESIGN:	OSCAR; Analytical Model
DATE:	2/84 HN

SHEET: A-5
OF
REVISION:

Finger Pier analytical model.

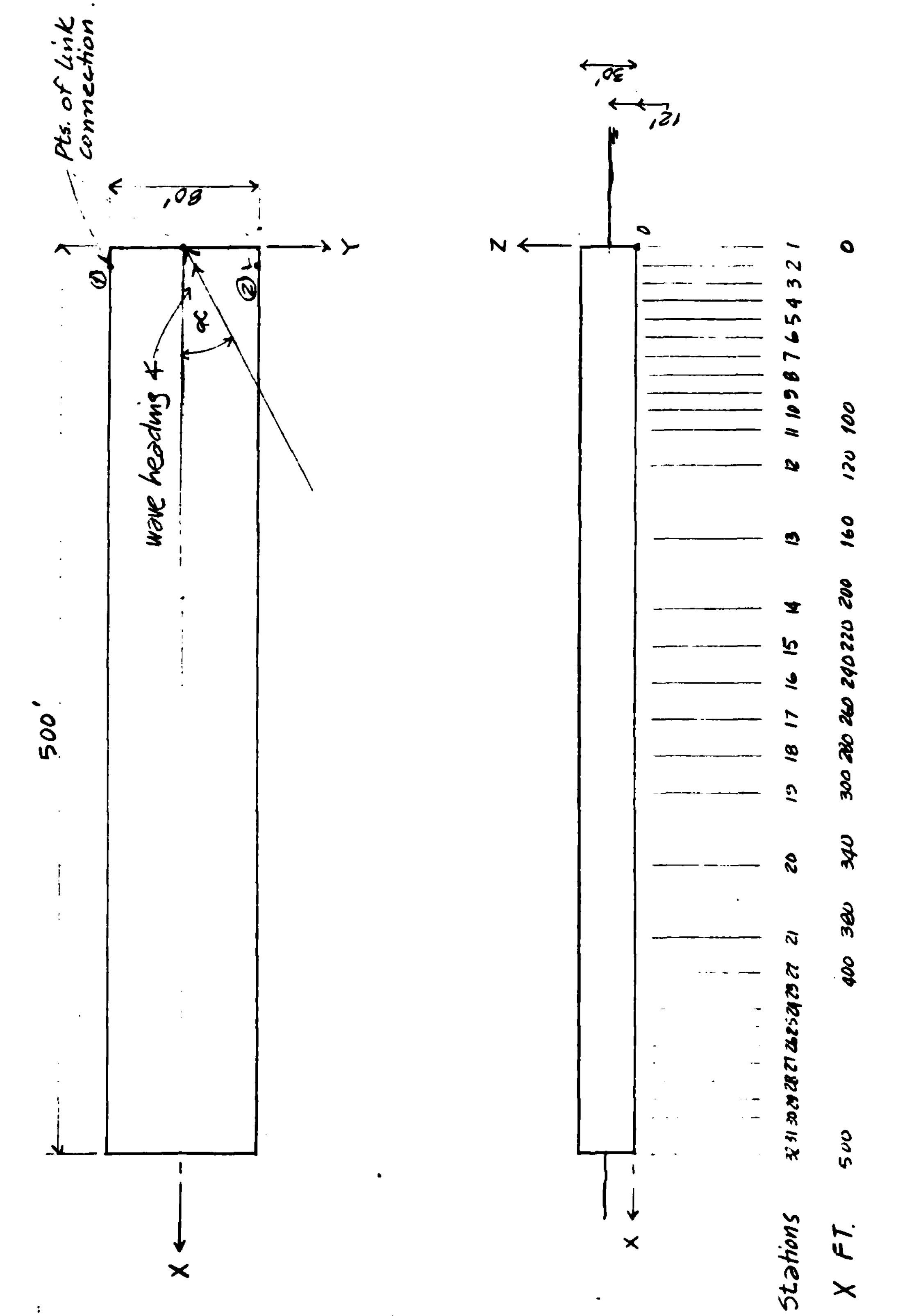

Fig A-1

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PROJECT:	ONR Navy Pier Concepts
ITEM:	Finger/spine conn.
DESIGN:	Free Floating Motions
DATE:	3/84 HN

SHEET: A-6
OF
REVISION:

SUMMARY OF FREE-FLOATING MOTIONS:

Motions for Average of 1/3 of spectral peaks.
Significant wave height = 6.0 ft., Mean period = 5.5 sec.

Heading (deg)	Surge (ft)	Sway (ft)	Heave (ft)	Roll (deg)	Pitch (deg.)	Yaw (deg)
180	0.268	0.0	0.399	0.0	0.091	0.0
160	0.260	0.25	0.844	0.003	0.191	0.057
135	0.253	0.629	1.182	0.614	0.270	0.144
110	0.296	1.368	2.314	0.812	0.483	0.260
100	0.147	1.503	1.848	1.913	0.216	0.126

Note: To obtain values that have a probability to be exceeded of 0.001, the above values should be multiplied by 1.92

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PROJECT:	ONR Navy Pier Concepts
ITEM:	Finger / Spine Conn.
DESIGN:	YAW RAO's.
DATE:	

SHEET: A-7
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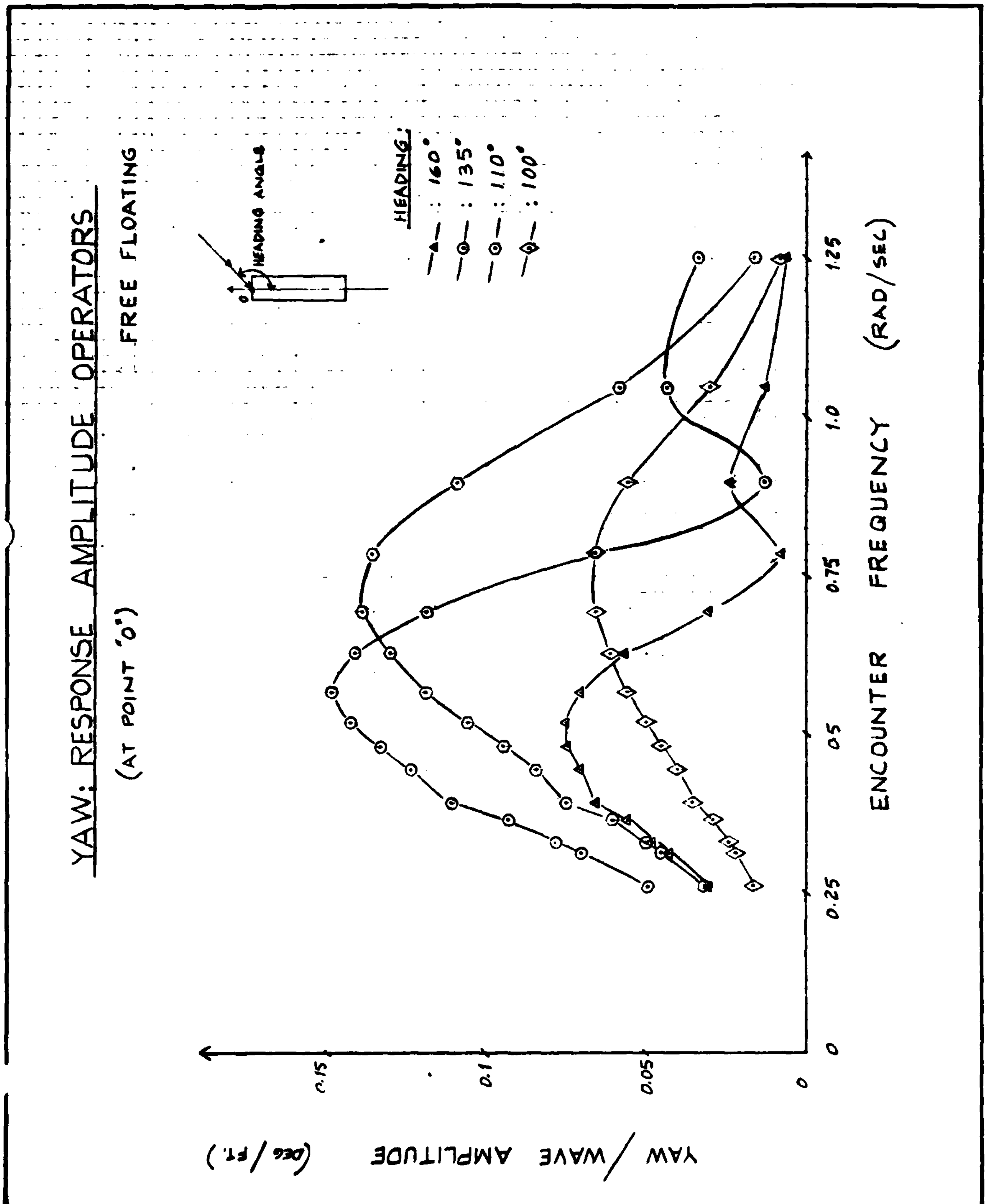
REVISION:



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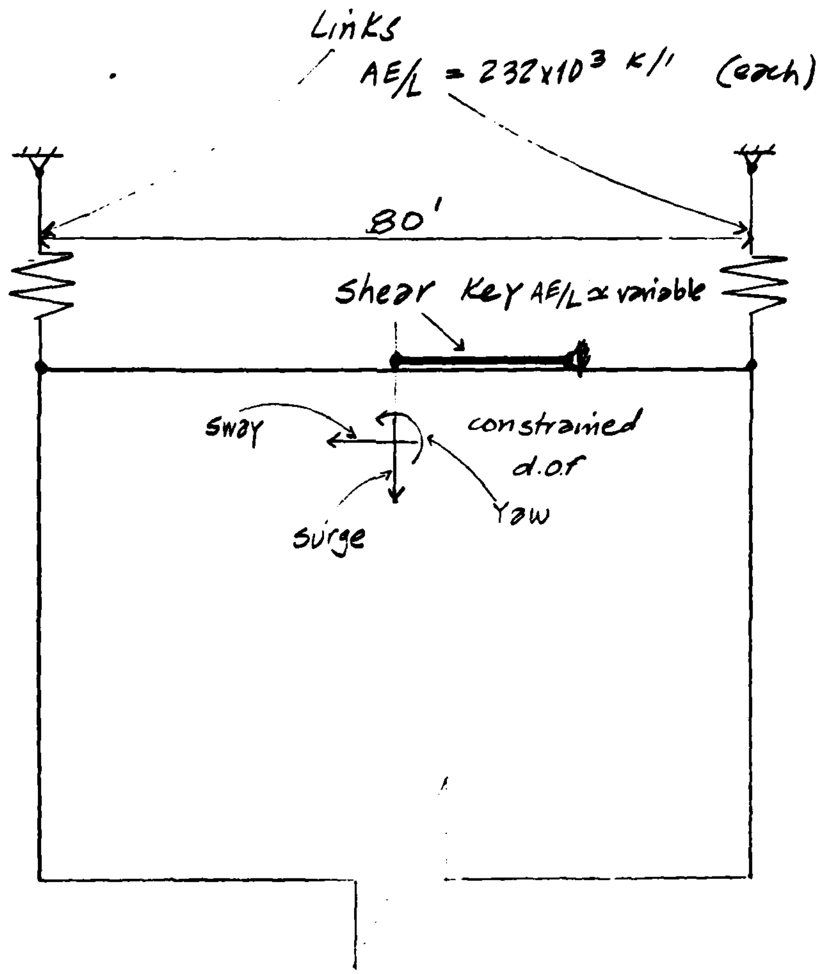
PROJECT:	ONR, Navy Pier Concepts
ITEM:	Finger/Spine conn.
DESIGN:	Conn. Analytical model
DATE:	2/84 HTV

SHEET: B-7
OF
REVISION:

Finger/Spine connection: Analytical Model.



Note: all motions in vertical plane are unconstrained.

Fig. B-1

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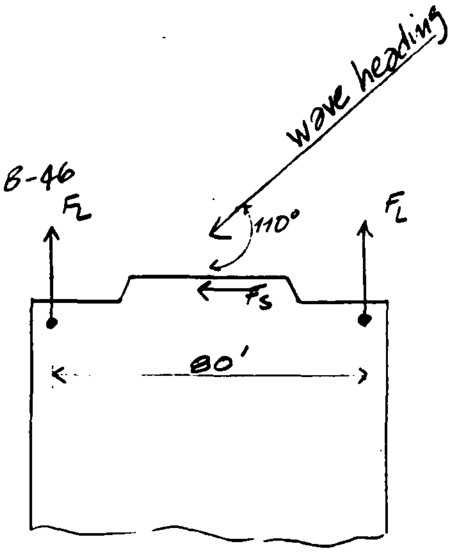
PROJECT:	ONR Navy Pier Concepts
ITEM:	Finger / Spine Connection
DESIGN:	Connection loading
DATE:	

SHEET: B-8
OF
REVISION:

Connection Loading:



Linear motion (wave) 110° heading FROM p. B-46

Surge : $440/2 = 220^K$ / Link

Sway : 1137^K

Yaw : $\frac{323400^{K\text{-}F}}{80^F} = \pm 4040^K$ / Link.

Wave Drift: (110° heading) FROM p.___

surge: $7.7/2 = 3.85^K$ / Link

sway: 42.7^K

Yaw : $\frac{10900^{K\text{-}F}}{80^F} = \pm 136^K$ / Link.

Wind and current: (broadside)

Total lateral force $= 30 + 62 = 92^K$ @ 333 FT. from conn.
(calculated on pp. A-1 & A-2)

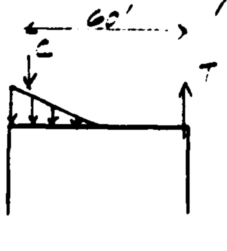
$\therefore$ Sway : $= 92^K$

Yaw : $= \frac{92 \times 333}{80} = \pm 383^K$ / link.

$\therefore \quad F_S = 1137 + 42.7 + 92 = 1272$ kips

$F_L = 220 + 4 + 4040 + 136 + 383 \simeq 4800$ kips
Tension or comp.
in each link.

If finger pier is allowed to bear against the spine pier at the compression end. The moment arm will be reduced.



Assume moment arm is 60'

$\therefore \quad F_L = 224 + (4559)\frac{80}{60} \simeq 6300$ kips
Tension.

*** OSCAR ***

DRAFT = 12.0 FEET TRIM ANGLE = 0.00 DEG.
HEADING = 180.00 DEG. FORWARD SPEED = 0.00 KNOT
ROLL GY. RADIUS =25.60 FEET PITCH GY. RADIUS = 145.0 F

V E S S E L   R E S P O N S E   O

OF BODY FRIEF

ENCOUNTER FREQUENCY (RAD/SEC)	ENCOUNTER PERIOD (SEC)	SURGE/ WAVE AMPL. AMPL.	SURGE/ WAVE AMPL. PHASE	SWAY/ WAVE AMPL. AMPL.	SWAY/ WAVE AMPL. PHASE	HEAVE/ WAVE AMPL. AMPL.	HEAVE/ WAVE AMPL. PHAS
.2513	25.000	.9863	-119.3	.0000	-88.8	.7474	-1
.3142	20.000	.9099	-134.8	.0000	-90.6	.8284	-19
.3307	19.000	.8889	-139.6	.0000	-91.4	.8545	-23
.3491	18.000	.8628	-145.4	.0000	-92.7	.8850	-27
.3696	17.000	.8292	-152.2	.0000	-94.8	.9196	-32
.3927	16.000	.7851	-160.5	.0000	-97.3	.9573	-39
.4189	15.000	.7265	-170.5	.0000	-101.0	.9958	-47
.4333	14.500	.6902	-176.4	.0000	-103.5	1.0137	-52
.4488	14.000	.6483	177.0	.0000	-106.2	1.0293	-58
.4654	13.500	.5998	169.7	.0000	-109.2	1.0407	-65
.4833	13.000	.5439	161.4	.0000	-113.0	1.0461	-72
.5027	12.500	.4798	151.9	.0000	-117.6	1.0422	-81
.5236	12.000	.4068	140.9	.0000	-122.5	1.0246	-90
.5464	11.500	.3247	127.9	.0000	-128.5	.9883	-102
.5712	11.000	.2342	111.9	.0000	-135.8	.9264	-114
.5984	10.500	.1384	89.4	.0000	-143.8	.8306	-129
.6283	10.000	.0520	35.1	.0000	-153.5	.6927	-145
.6614	9.500	.0788	-78.5	.0000	-164.0	.5062	-163
.6981	9.000	.1517	-119.4	.0000	-174.8	.2756	-170
.7392	8.500	.1939	-153.2	.0000	-175.7	.1108	-120
.7854	8.000	.1813	168.9	.0000	-99.9	.3115	-107
.8378	7.500	.1023	118.5	.0000	-96.8	.4647	-145
.8976	7.000	.0365	-49.9	.0000	-125.2	.3755	-162
.9666	6.500	.1028	-146.4	.0000	-156.3	.1368	165
1.0472	6.000	.0440	152.1	.0000	-89.7	.2962	112
1.1424	5.500	.0628	-137.4	.0000	-144.2	.1336	1
1.2566	5.000	.0101	146.5	.0000	-137.8	.1192	-44
1.3963	4.500	.0127	129.5	.0000	127.0	.0244	-31
1.5708	4.000	.0191	-113.3	.0000	-86.6	.0915	-41
2.0944	3.000	.0005	9.7	.0000	-149.9	.0634	-121

1

*** OSCAR ***

DATE 84/02/1

NGLE = 0.00 DEG.
D SPEED = 0.00 KNOTS
GY. RADIUS = 145.0 FEET

G-METACENTER = 32.4 FEET
WAVE STEEPNESS = 1/ 20
YAW GY. RADIUS = 145.0 FEET

R E S P O N S E   O P E R A T O R S

OF BODY FRIER

AMPL.	HEAVE/ WAVE AMPL.		ROLL/ WAVE AMPL.		PITCH/ WAVE AMPL.		YAW/ WAVE AMPL.	
PHASE	AMPL.	PHASE	AMPL.	PHASE	AMPL.	PHASE	AMPL.	PHASE
-88.8	.7474	-11.0	.0000	-90.0	.0911	54.0	.0000	158.7
-90.6	.8284	-19.9	.0000	-90.0	.1327	30.3	.0000	143.6
-91.4	.8545	-23.1	.0000	-90.0	.1445	23.4	.0000	139.4
-92.7	.8850	-27.2	.0000	-90.0	.1576	15.4	.0000	134.3
-94.8	.9196	-32.4	.0000	-90.0	.1721	6.0	.0000	128.3
-97.3	.9573	-39.0	.0000	-90.0	.1875	-5.0	.0000	121.4
-101.0	.9958	-47.5	.0000	-90.0	.2032	-18.1	.0000	113.2
-103.5	1.0137	-52.6	.0000	-90.0	.2109	-25.6	.0000	108.3
-106.2	1.0293	-58.4	.0000	-90.0	.2180	-33.8	.0000	103.1
-109.2	1.0407	-65.0	.0000	-90.0	.2241	-42.9	.0000	97.5
-113.0	1.0461	-72.5	.0000	175.0	.2288	-53.0	.0000	90.0
-117.6	1.0422	-81.1	.0000	90.0	.2313	-64.3	.0000	83.6
-122.5	1.0246	-90.9	.0000	90.0	.2304	-77.0	.0000	75.8
-128.5	.9883	-102.0	.0000	90.0	.2250	-91.2	.0000	66.7
-135.8	.9264	-114.9	.0000	90.0	.2133	-107.5	.0000	56.0
-143.8	.8306	-129.4	.0000	90.0	.1933	-126.1	.0000	44.2
-153.5	.6927	-145.9	.0000	90.0	.1627	-147.8	.0000	29.9
-164.0	.5062	-163.7	.0000	-90.0	.1197	-173.5	.0000	13.3
-174.8	.2756	-178.0	.0000	-90.0	.0639	153.4	.0000	-7.7
-175.7	.1108	-128.5	.0000	-161.0	.0106	21.7	.0000	-38.4
-99.9	.3115	-107.9	.0000	142.9	.0691	-85.4	.0000	148.4
-96.8	.4647	-145.2	.0000	90.0	.1102	-141.7	.0000	99.1
-125.2	.3755	-162.5	.0000	-90.0	.0924	-148.0	.0000	53.3
-156.3	.1368	165.3	.0000	90.0	.0055	-14.8	.0000	-6.3
-89.7	.2962	112.1	.0000	90.0	.0652	120.1	.0000	124.1
-144.2	.1336	11.0	.0000	90.0	.0247	-27.8	.0000	27.4
-137.8	.1192	-44.2	.0000	90.0	.0260	-21.0	.0000	109.1
127.0	.0244	-37.8	.0000	-90.0	.0057	.1	.0000	-70.6
-86.6	.0915	-41.3	.0000	-90.0	.0117	-76.2	.0000	76.6
-149.9	.0634	-127.6	.0000	-90.0	.0064	-74.3	.0000	-22.7

2

*** OSCAR

DRAFT = 12.0 FEET TRIM ANGLE = 0.00 DEG.
HEADING = 180.00 DEG. FORWARD SPEED = 0.00 KN
ROLL GY. RADIUS =25.60 FEET PITCH GY. RADIUS = 145.0

S T A T I S T I C S O F M O T I O N S

OF BODY FPIER

S E A S P E C T R

ISSC --- SIGNIFICANT HEIGHT = 6.0 FEET

S I N G L E A M P L I T U D

	SURGE -(FEET)-	SWAY -(FEET)-
ROOT MEAN SQUARE	.134	.000
AVE OF 1/3 HIGHEST	.268	.000
AVE OF 1/10 HIGHEST	.341	.000
AVE OF 1/100 HIGHEST	.447	.000

S T A T I S T I C S O F A C C E L E R A T I O N

S I N G L E A M P L

	SURGE (FEET /SEC**2)	SWAY (FEET /SEC**2)	HEAVE (FEET /SE
ROOT MEAN SQUARE	.100	.000	.33
AVE OF 1/3 HIGHEST	.200	.000	.67
AVE OF 1/10 HIGHEST	.255	.000	.86
AVE OF 1/100 HIGHEST	.334	.000	1.12

(1)

*** OSCAR ***

DATE 84/02/1

M ANGLE = 0.00 DEG. G-METACENTER = 32.4 FEET
.ARD SPEED = 0.00 KNOTS WAVE STEEPNESS = 1/ 20
CH GY. RADIUS = 145.0 FEET YAW GY. RADIUS = 145.0 FEET

F M O T I O N S I N I R R E G U L A R S E A S

OF BODY FPIER

S E A S P E C T R U M

HEIGHT = 6.0 FEET MEAN PERIOD = 5.5 SECONDS

L E A M P L I T U D E M O T I O N S

GF T)-	SWAY -(FEET)-	HEAVE -(FEET)-	ROLL --(DEG)--	PITCH --(DEG)--	YAW --(DEG)--
.134	.000	.399	.000	.091	.000
.268	.000	.797	.000	.182	.000
.341	.000	1.017	.000	.231	.000
.447	.000	1.332	.000	.303	.000

C E L E R A T I O N I N I R R E G U L A R S E A S

S I N G L E A M P L I T U D E S

AY SEC**2)	HEAVE (FEET /SEC**2)	ROLL (DEG/SEC**2)	PITCH (DEG/SEC**2)	YAW (DEG/SEC**2)
.000	.338	.000	.072	.000
.000	.675	.000	.144	.000
.000	.861	.000	.184	.000
.000	1.128	.000	.241	.000

*** OSCAR **

DRAFT = 12.0 FEET TRIM ANGLE = 0.00 DEG.
HEADING = 160.00 DEG. FORWARD SPEED = 0.00 KNO
ROLL GY. RADIUS =25.60 FEET PITCH GY. RADIUS = 145.0

V E S S E L R E S P O N S E O

OF BODY FPIER

E N C O U N T E R		SURGE/ WAVE AMPL.		SWAY/ WAVE AMPL.		HEAVE/ WAVE AM	
FREQUENCY (RAD/SEC)	PERIOD (SEC)	AMPL.	PHASE	AMPL.	PHASE	AMPL.	PHA
.2513	25.000	.9249	-117.3	.2853	91.2	.7378	-1
.3142	20.000	.8599	-131.8	.2991	89.4	.8114	-1
.3307	19.000	.8427	-136.3	.3051	88.6	.8357	-2
.3491	18.000	.8213	-141.7	.3122	87.3	.8644	-2
.3696	17.000	.7938	-148.1	.3203	85.2	.8977	-3
.3927	16.000	.7575	-155.8	.3293	82.7	.9352	-3
.4189	15.000	.7091	-165.2	.3363	79.0	.9752	-4
.4333	14.500	.6789	-170.7	.3422	76.5	.9950	-4
.4488	14.000	.6437	-176.8	.3455	73.8	1.0136	-5
.4654	13.500	.6029	176.3	.3477	70.8	1.0296	-6
.4833	13.000	.5555	168.6	.3460	67.0	1.0414	-6
.5027	12.500	.5006	159.8	.3457	62.4	1.0463	-7
.5236	12.000	.4375	149.7	.3398	57.5	1.0407	-8
.5464	11.500	.3654	137.9	.3288	51.5	1.0200	-9
.5712	11.000	.2843	123.8	.3110	44.2	.9780	-10
.5984	10.500	.1956	105.8	.2845	36.2	.9067	-12
.6283	10.000	.1037	77.8	.2468	26.5	.7971	-13
.6614	9.500	.0422	-10.3	.1964	16.0	.6399	-15
.6981	9.000	.0995	-95.2	.1329	5.2	.4302	-17
.7392	8.500	.1596	-132.6	.0618	4.3	.1865	17
.7854	8.000	.1780	-169.0	.0423	80.1	.1862	-1
.8378	7.500	.1338	147.3	.0985	83.2	.4092	-1
.8976	7.000	.0348	67.9	.1183	54.8	.4628	1
.9666	6.500	.0773	-115.0	.0669	23.7	.2160	1
1.0472	6.000	.0751	-179.1	.0601	90.3	.2388	1
1.1424	5.500	.0248	-133.0	.1012	35.8	.1985	[illegible]
1.2566	5.000	.0477	164.1	.0428	42.2	.0926	-
1.3963	4.500	.0393	-174.3	.0199	-53.0	.0265	-1
1.5708	4.000	.0246	162.9	.0376	93.4	.0620	[illegible]
2.0944	3.000	.0068	-91.3	.0218	30.1	.0266	-

*** OSCAR ***

DATE 84/02/1

LE = 0.00 DEG.
SPEED = 0.00 KNOTS
. RADIUS = 145.0 FEET

G-METACENTER = 32.4 FEET
WAVE STEEPNESS = 1/ 20
YAW GY. RADIUS = 145.0 FEET

ESPONSE OPERATORS

OF BODY FPIER

MPL.	HEAVE/ WAVE AMPL.		ROLL/ WAVE AMPL.		PITCH/ WAVE AMPL.		YAW/ WAVE AMPL.	
ASE	AMPL.	PHASE	AMPL.	PHASE	AMPL.	PHASE	AMPL.	PHASE
91.2	.7378	-10.9	.0006	63.0	.0854	56.4	.0311	-21.3
89.4	.8114	-19.1	.0009	49.4	.1248	33.6	.0436	-36.4
88.6	.8357	-22.1	.0009	45.3	.1362	27.0	.0473	-40.6
87.3	.8644	-25.8	.0010	40.4	.1489	19.3	.0515	-45.7
85.2	.8977	-30.6	.0011	34.4	.1630	10.3	.0561	-51.7
82.7	.9352	-36.7	.0012	27.4	.1784	-.2	.0609	-58.6
79.0	.9752	-44.6	.0013	18.9	.1946	-12.7	.0659	-66.8
76.5	.9950	-49.3	.0014	13.8	.2028	-19.9	.0683	-71.7
73.8	1.0136	-54.7	.0014	8.3	.2107	-27.7	.0706	-76.9
70.8	1.0296	-60.8	.0014	2.1	.2180	-36.4	.0725	-82.5
67.0	1.0414	-67.9	.0015	-5.0	.2243	-46.0	.0741	-89.0
62.4	1.0463	-75.9	.0015	-13.1	.2289	-56.8	.0749	-96.4
57.5	1.0407	-85.1	.0014	-22.3	.2311	-68.8	.0749	-104.2
51.5	1.0200	-95.6	.0013	-33.2	.2296	-82.3	.0736	-113.3
44.2	.9780	-107.8	.0011	-46.4	.2229	-97.8	.0705	-124.0
36.2	.9067	-121.7	.0008	-63.0	.2091	-115.3	.0653	-135.8
26.5	.7971	-137.7	.0004	-89.8	.1857	-135.7	.0571	-150.1
16.0	.6399	-155.6	.0003	104.7	.1505	-159.6	.0456	-166.7
5.2	.4302	-174.3	.0012	60.9	.1014	171.5	.0305	172.3
-4.3	.1865	179.5	.0023	-19.0	.0393	131.0	.0125	141.6
30.1	.1862	-111.3	.0028	-37.1	.0332	-61.0	.0078	-31.6
33.2	.4092	-132.7	.0017	-108.0	.0934	-120.9	.0232	-80.9
54.8	.4628	-176.8	.0003	76.9	.1109	172.5	.0282	-126.7
23.7	.2160	125.0	.0010	-45.0	.0483	83.6	.0148	173.7
90.3	.2388	126.0	.0006	-126.9	.0433	151.6	.0131	-55.9
35.8	.1985	28.5	.0001	-12.2	.0439	16.4	.0237	-152.6
42.2	.0926	-20.9	.0001	-96.5	.0124	28.8	.0068	-70.9
53.0	.0265	-120.1	.0001	36.7	.0065	-145.1	.0054	109.4
93.4	.0620	1.1	.0002	140.6	.0110	-15.3	.0074	-103.4
30.1	.0266	-59.8	.0006	86.8	.0046	-94.8	.0038	157.3

*** USCAP

DRAFT = 12.0 FEET TRIM ANGLE = 0.00 DE
HEADING = 160.00 DEG. FORWARD SPEED = 0.00
ROLL GY. RADIUS =25.60 FEET PITCH GY. RADIUS = 145

S T A T I S T I C S O F M O T I O N S

OF BODY FPIER

S E A S P E C T

ISSC --- SIGNIFICANT HEIGHT = 6.0 FEET

S I N G L E A M P L I T U

	SURGE (FEET)	SWAY (FEET)
ROOT MEAN SQUARE	.130	.125
AVE OF 1/3 HIGHEST	.260	.250
AVE OF 1/10 HIGHEST	.332	.319
AVE OF 1/100 HIGHEST	.434	.418

S T A T I S T I C S O F A C C E L E R A T I O N

S I N G L E A M P

	SURGE (FEET /SEC**2)	SWAY (FEET /SEC**2)	HEAV (FEET /S
ROOT MEAN SQUARE	.106	.117	.3
AVE OF 1/3 HIGHEST	.211	.235	.6
AVE OF 1/10 HIGHEST	.269	.299	.8
AVE OF 1/100 HIGHEST	.352	.392	1.1

*** OSCAR ***

DATE . 84/02/1

M ANGLE = 0.00 DEG.
WARD SPEED = 0.00 KNOTS
CH GY. RADIUS = 145.0 FEET

G-METACENTER = 32.4 FEET
WAVE STEEPNESS = 1/ 20
YAW GY. RADIUS = 145.0 FEET

F MOTIONS IN IRREGULAR SEAS

OF BODY FPIER

SEA SPECTRUM

HEIGHT = 6.0 FEET MEAN PERIOD = 5.5 SECONDS

E AMPLITUDE MOTIONS

E -)-	SWAY -(FEET)-	HEAVE -(FEET)-	ROLL --(DEG)--	PITCH --(DEG)--	YAW --(DEG)--
130	.125	.422	.002	.096	.029
260	.250	.844	.003	.191	.057
332	.319	1.076	.004	.244	.073
434	.418	1.410	.006	.319	.096

ELERATION IN IRREGULAR SEAS

INGLE AMPLITUDES

Y EC**2)	HEAVE (FEET /SEC**2)	ROLL (DEG/SEC**2)	PITCH (DEG/SEC**2)	YAW (DEG/SEC**2)
17	.339	.001	.074	.026
35	.677	.003	.148	.052
99	.864	.003	.188	.066
92	1.131	.004	.247	.087

2

*** OSCAR ***

DRAFT = 12.0 FEET TRIM ANGLE = 0.00 DEG.
HEADING = 135.00 DEG. FORWARD SPEED = 0.00 KNOTS
ROLL GY. RADIUS =25.60 FEET PITCH GY. RADIUS = 145.0 FEET

VESSEL RESPONSE OPE

OF BODY FRIEN

E N C O U N T E R		SURGE/ WAVE AMPL.		SWAY/ WAVE AMPL.		HEAVE/ WAVE AMPL.	
FREQUENCY (RAD/SEC)	PERIOD (SEC)	AMPL.	PHASE	AMPL.	PHASE	AMPL.	PHASE
.2513	25.000	.7136	-110.7	.5991	90.9	.7090	-10.7
.3142	20.000	.6783	-121.8	.6128	89.9	.7571	-17.1
.3307	19.000	.6707	-125.3	.6220	89.5	.7742	-19.3
.3491	18.000	.6614	-129.4	.6333	88.8	.7953	-22.1
.3696	17.000	.6495	-134.3	.6466	87.5	.8212	-25.6
.3927	16.000	.6336	-140.2	.6620	86.1	.8527	-30.1
.4189	15.000	.6118	-147.5	.6789	84.0	.8905	-35.9
.4333	14.500	.5978	-151.7	.6874	82.5	.9118	-39.5
.4488	14.000	.5813	-156.4	.6956	80.8	.9344	-43.5
.4654	13.500	.5618	-161.6	.7031	79.0	.9581	-48.2
.4833	13.000	.5386	-167.6	.7092	76.7	.9825	-53.5
.5027	12.500	.5109	-174.3	.7131	73.7	1.0066	-59.8
.5236	12.000	.4780	178.1	.7133	70.7	1.0288	-66.9
.5464	11.500	.4388	169.3	.7085	66.9	1.0472	-75.2
.5712	11.000	.3923	159.0	.6963	62.1	1.0588	-84.9
.5984	10.500	.3377	146.9	.6739	56.9	1.0584	-96.2
.6283	10.000	.2742	132.2	.6379	50.3	1.0396	-109.6
.6614	9.500	.2023	113.5	.5843	42.9	.9928	-125.3
.6981	9.000	.1250	86.3	.5087	33.9	.9051	-144.0
.7392	8.500	.0589	28.5	.4093	24.4	.7602	-166.1
.7854	8.000	.0730	-71.1	.2897	16.2	.5413	168.5
.8378	7.500	.1202	-123.2	.1768	18.6	.2482	148.2
.8976	7.000	.1262	-167.8	.1446	36.4	.2098	-149.9
.9666	6.500	.0668	146.5	.0342	49.5	.4722	165.8
1.0472	6.000	.0172	-120.7	.1974	31.2	.3716	87.8
1.1424	5.500	.0650	-142.2	.0321	3.8	.1008	-49.8
1.2566	5.000	.0378	148.9	.1455	49.1	.1558	14.0
1.3963	4.500	.0441	-163.8	.0508	-6.8	.0522	-52.1
1.5708	4.000	.0294	-147.7	.0341	-73.1	.0276	-121.1
2.0944	3.000	.0076	150.3	.0124	-179.2	.0007	-168.9

A-12

OSCAR ***

DATE 84/02/1.

0.00 DEG. G-METACENTER = 32.4 FEET
= 0.00 KNOTS WAVE STEEPNESS = 1/ 20
US = 145.0 FEET YAW GY. RADIUS = 145.0 FEET

UNSE OPERATORS

UY FRIER

EAVE/ WAVE AMPL. AMPL.	PHASE	ROLL/ WAVE AMPL. AMPL.	PHASE	PITCH/ WAVE AMPL. AMPL.	PHASE	YAW/ WAVE AMPL. AMPL.	PHASE
.7090	-10.7	.0593	69.4	.0661	65.4	.0500	-13.3
.7571	-17.1	.0877	59.1	.0975	45.2	.0710	-25.6
.7742	-19.3	.0959	56.1	.1069	39.4	.0774	-29.0
.7953	-22.1	.1052	52.4	.1176	32.8	.0847	-32.9
.8212	-25.6	.1156	47.9	.1299	25.1	.0930	-37.6
.8527	-30.1	.1270	42.8	.1440	16.2	.1023	-42.8
.8905	-35.9	.1391	36.6	.1599	5.6	.1124	-49.1
.9118	-39.5	.1452	32.9	.1685	-.4	.1178	-52.8
.9344	-43.5	.1512	28.9	.1776	-7.0	.1232	-56.7
.9581	-48.2	.1569	24.6	.1869	-14.3	.1286	-60.8
.9825	-53.5	.1619	19.6	.1965	-22.3	.1339	-65.7
1.0066	-59.8	.1657	13.9	.2061	-31.3	.1388	-71.2
1.0288	-66.9	.1678	7.8	.2153	-41.3	.1430	-77.0
1.0472	-75.2	.1672	.6	.2236	-52.6	.1462	-83.7
1.0588	-84.9	.1627	-7.8	.2303	-65.4	.1476	-91.6
1.0584	-96.2	.1525	-17.2	.2342	-79.9	.1467	-100.2
1.0396	-109.6	.1346	-28.6	.2338	-96.7	.1423	-110.7
.9928	-125.3	.1059	-42.5	.2265	-116.1	.1334	-122.8
.9051	-144.0	.0635	-61.4	.2094	-139.2	.1182	-137.5
.7602	-166.1	.0103	-149.4	.1784	-167.0	.0958	-155.3
.5413	168.5	.0805	93.2	.1287	158.5	.0651	-178.1
.2482	148.2	.1854	58.6	.0574	110.9	.0275	149.1
.2098	-149.9	.3213	13.9	.0341	-97.2	.0138	-31.8
.4722	165.8	.4746	-89.6	.1051	176.0	.0427	-90.3
.3716	87.8	.0895	-19.2	.0876	78.1	.0437	-148.0
.1008	-49.8	.0849	-116.0	.0062	-40.9	.0067	110.2
.1558	14.0	.0067	127.0	.0357	20.0	.0343	-125.8
.0522	-52.1	.0119	32.7	.0036	-140.9	.0052	80.2
.0276	-121.1	.0032	106.1	.0070	-124.5	.0089	104.2
.0007	-168.9	.0047	-51.0	.0000	52.7	.0013	-41.3

*** OSCAR ***

DRAFT = 12.0 FEET TRIM ANGLE = 0.00 DEG.
HEADING = 135.00 DEG. FORWARD SPEED = 0.00 KNOTS
ROLL GY. RADIUS =25.60 FEET PITCH GY. RADIUS = 145.0 FEET

S T A T I S T I C S O F M O T I O N S I N I

OF BODY FPIER

S E A S P E C T R U M

ISSC --- SIGNIFICANT HEIGHT = 6.0 FEET MEAN

S I N G L E A M P L I T U D E M

	SURGE -(FEET)-	SWAY -(FEET)-	HEAVE -(FEET)-
ROOT MEAN SQUARE	.126	.314	.591
AVE OF 1/3 HIGHEST	.253	.629	1.182
AVE OF 1/10 HIGHEST	.322	.801	1.507
AVE OF 1/100 HIGHEST	.422	1.050	1.974

S T A T I S T I C S O F A C C E L E R A T I O N I N

S I N G L E A M P L I T U

	SURGE (FEET /SEC**2)	SWAY (FEET /SEC**2)	HEAVE (FEET /SEC**2)
ROOT MEAN SQUARE	.105	.226	.428
AVE OF 1/3 HIGHEST	.211	.453	.856
AVE OF 1/10 HIGHEST	.268	.577	1.091
AVE OF 1/100 HIGHEST	.352	.756	1.429

*** OSCAR ***

DATE 84/02/1

NGLE = 0.00 DEG.
D SPEED = 0.00 KNOTS
GY. RADIUS = 145.0 FEET

G-METACENTER = 32.4 FEET
WAVE STEEPNESS = 1/ 20
YAW GY. RADIUS = 145.0 FEET

MOTIONS IN IRREGULAR SEAS

OF BODY FPIER

EA SPECTRUM

GHT = 6.0 FEET MEAN PERIOD = 5.5 SECONDS

AMPLITUDE MOTIONS

SWAY (FEET)	HEAVE (FEET)	ROLL (DEG)	PITCH (DEG)	YAW (DEG)
.314	.591	.307	.135	.072
.629	1.182	.614	.270	.144
.801	1.507	.783	.344	.184
1.050	1.974	1.025	.450	.241

LERATION IN IRREGULAR SEAS

NGLE AMPLITUDES

**2)	HEAVE (FEET /SEC**2)	ROLL (DEG/SEC**2)	PITCH (DEG/SEC**2)	YAW (DEG/SEC**2)
	.428	.274	.096	.053
	.856	.548	.193	.106
	1.091	.699	.245	.135
	1.429	.915	.322	.177

*** OSCAR ***

DRAFT = 12.0 FEET TRIM ANGLE = 0.00 DEG.
HEADING = 110.00 DEG. FORWARD SPEED = 0.00 KNOTS
ROLL GY. RADIUS =25.60 FEET PITCH GY. RADIUS = 145.0 FE

V E S S E L R E S P O N S E O P

OF BODY FRIEH

ENCOUNTER FREQUENCY (RAD/SEC)	ENCOUNTER PERIOD (SEC)	SURGE/WAVE AMPL. AMPL.	SURGE/WAVE AMPL. PHASE	SWAY/WAVE AMPL. AMPL.	SWAY/WAVE AMPL. PHASE	HEAVE/WAVE AMPL. AMPL.	HEAVE/WAVE AMPL. PHASE
.2513	25.000	.3493	-100.9	.7637	91.0	.6765	-11.
.3142	20.000	.3391	-107.2	.7574	91.4	.6894	-16.
.3307	19.000	.3361	-109.1	.7614	91.6	.6945	-18.
.3491	18.000	.3371	-111.5	.7666	91.7	.7013	-20.
.3696	17.000	.3359	-114.3	.7733	91.6	.7103	-22.
.3927	16.000	.3341	-117.7	.7817	91.7	.7224	-25.
.4189	15.000	.3315	-121.8	.7917	91.7	.7388	-28.
.4333	14.500	.3297	-124.2	.7971	91.5	.7492	-30.
.4488	14.000	.3275	-126.9	.8029	91.3	.7612	-33.
.4654	13.500	.3247	-129.9	.8090	91.3	.7751	-35.
.4833	13.000	.3212	-133.3	.8151	90.9	.7913	-38.
.5027	12.500	.3168	-137.2	.8212	90.3	.8103	-42.
.5236	12.000	.3113	-141.5	.8267	89.9	.8322	-46.
.5464	11.500	.3044	-146.6	.8313	89.1	.8576	-51.
.5712	11.000	.2956	-152.4	.8344	87.8	.8870	-56.
.5984	10.500	.2845	-159.1	.8343	86.5	.9204	-63.
.6283	10.000	.2702	-167.1	.8303	84.3	.9587	-71.
.6614	9.500	.2521	-176.6	.8197	81.7	1.0013	-80.
.6981	9.000	.2288	171.9	.8001	77.7	1.0480	-92.
.7392	8.500	.1990	157.4	.7679	72.6	1.0969	-107.
.7854	8.000	.1610	138.7	.7184	65.4	1.1431	-125.
.8378	7.500	.1134	112.1	.6459	55.7	1.1722	-150.
.8976	7.000	.0595	65.5	.5464	43.5	1.1420	-175.
.9666	6.500	.0366	-45.4	.4871	30.7	.9392	129.
1.0472	6.000	.0495	-118.0	.2796	-7.3	.4955	73.
1.1424	5.500	.0510	-140.2	.0749	-30.6	.1374	-44.
1.2566	5.000	.0539	-173.3	.0931	65.1	.1144	49.
1.3963	4.500	.0192	128.7	.1220	4.3	.0911	-14.
1.5708	4.000	.0267	-149.6	.0347	-7.6	.0186	-18.
2.0944	3.000	.0079	-115.7	.0200	160.8	.0024	119.

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*** OSCAR ***
---------------                              DATE  84/02/1

IGLE =    0.00 DEG.                 G-METACENTER =    32.4 FEET
) SPEED =  0.00 KNOTS               WAVE STEEPNESS = 1/ 20
GY. RADIUS = 145.0 FEET             YAW GY. RADIUS = 145.0 FEET
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RESPONSE OPERATORS

OF BODY FRIEF

MPL.	HEAVE/ WAVE AMPL.		ROLL/ WAVE AMPL.		PITCH/ WAVE AMPL.		YAW/ WAVE AMPL.	
HASE	AMPL.	PHASE	AMPL.	PHASE	AMPL.	PHASE	AMPL.	PHASE
91.0	.6765	-11.4	.0794	80.3	.0340	85.0	.0323	3.6
91.4	.6894	-16.6	.1198	75.6	.0495	66.6	.0457	-6.3
91.6	.6945	-18.4	.1321	74.3	.0543	61.7	.0500	-8.6
91.7	.7013	-20.3	.1464	72.7	.0599	56.3	.0550	-11.1
91.6	.7103	-22.6	.1631	70.7	.0665	50.1	.0608	-14.1
91.7	.7224	-25.4	.1826	68.5	.0744	43.1	.0675	-17.2
91.7	.7388	-28.8	.2055	65.9	.0838	35.1	.0753	-20.8
91.5	.7492	-30.9	.2184	64.2	.0892	30.5	.0796	-22.9
91.3	.7612	-33.2	.2323	62.5	.0951	25.6	.0843	-25.0
91.3	.7751	-35.8	.2473	60.7	.1015	20.2	.0893	-27.1
90.9	.7913	-38.8	.2634	58.6	.1087	14.3	.0945	-29.6
90.3	.8103	-42.3	.2807	56.1	.1166	7.8	.1001	-32.5
89.9	.8322	-46.3	.2989	53.6	.1253	.6	.1059	-35.3
89.1	.8576	-51.1	.3181	50.6	.1349	-7.5	.1119	-38.6
87.8	.8870	-56.7	.3380	47.0	.1455	-16.6	.1180	-42.6
86.5	.9204	-63.2	.3577	43.2	.1572	-26.8	.1240	-46.7
84.3	.9587	-71.2	.3768	38.3	.1701	-38.6	.1296	-52.0
81.7	1.0013	-80.7	.3934	32.6	.1841	-52.2	.1344	-57.8
77.7	1.0480	-92.6	.4058	25.4	.1992	-68.3	.1377	-65.3
72.6	1.0969	-107.2	.4103	16.7	.2151	-87.4	.1388	-74.2
65.4	1.1431	-125.9	.4020	5.6	.2308	-110.9	.1364	-85.8
55.7	1.1722	-150.5	.3715	-8.4	.2434	-140.9	.1289	-100.6
43.5	1.1420	-175.9	.2952	-24.9	.2444	-179.2	.1144	-120.0
30.7	.9392	129.0	.2733	13.3	.2087	124.0	.0911	-145.8
-7.3	.4955	73.1	.3274	-64.7	.1151	53.0	.0583	179.3
30.6	.1374	-44.2	.1715	-109.2	.0238	-26.1	.0188	126.5
65.1	.1144	49.1	.0502	-153.3	.0176	73.0	.0171	-91.4
4.3	.0911	-14.4	.0124	-115.6	.0191	-25.4	.0256	176.1
-7.6	.0186	-18.3	.0055	79.6	.0008	89.0	.0019	-39.7
60.8	.0024	119.1	.0017	-104.9	.0006	108.1	.0047	-34.4

*** USCAP ***

DRAFT = 12.0 FEET | TRIM ANGLE = 0.00 DEG.
HEADING = 110.00 DEG. | FORWARD SPEED = 0.00 KNOTS
ROLL GY. RADIUS =25.60 FEET | PITCH GY. RADIUS = 145.0 FE

S T A T I S T I C S O F M O T I O N S I N

OF BODY FPIER

S E A S P E C T R U

ISSC --- SIGNIFICANT HEIGHT = 6.0 FEET

S I N G L E A M P L I T U D E

	SURGE -(FEET)-	SWAY -(FEET)-	HEA -(FEE
ROOT MEAN SQUARE	.148	.684	1
1.92X AVE OF 1/3 HIGHEST	.296	1.368	2
AVE OF 1/10 HIGHEST	.377	1.744	2
AVE OF 1/100 HIGHEST	.494	2.284	3

S T A T I S T I C S O F A C C E L E R A T I O N I

S I N G L E A M P L I

	SURGE (FEET /SEC**2)	SWAY (FEET /SEC**2)	HEAVE (FEET /SEC**
ROOT MEAN SQUARE	.105	.497	.876
AVE OF 1/3 HIGHEST	.209	.995	1.751
AVE OF 1/10 HIGHEST	.267	1.268	2.233
AVE OF 1/100 HIGHEST	.349	1.661	2.925

*** USCAR ***

DATE 84/02/1

ANGLE = 0.00 DEG.
RD SPEED = 0.00 KNOTS
GY. RADIUS = 145.0 FEET

G-METACENTER = 32.4 FEET
WAVE STEEPNESS = 1/ 20
YAW GY. RADIUS = 145.0 FEET

M O T I O N S   I N   I R R E G U L A R   S E A S

OF BODY FRIER

S E A   S P E C T R U M

IGHT = 6.0 FEET   MEAN PERIOD = 5.5 SECONDS

E   A M P L I T U D E   M O T I O N S

	SWAY (FEET)	HEAVE (FEET)	ROLL (DEG)	PITCH (DEG)	YAW (DEG)
48	.684	1.157	.406	.241	.130
96	1.368	2.314	.812	.483	.260
77	1.744	2.951	1.035	.616	.331
94	2.284	3.865	1.356	.806	.434

E L E R A T I O N   I N   I R R E G U L A R   S E A S

N G L E   A M P L I T U D E S

EC**2)	HEAVE (FEET /SEC**2)	ROLL (DEG/SEC**2)	PITCH (DEG/SEC**2)	YAW (DEG/SEC**2)
97	.876	.329	.187	.097
95	1.751	.658	.373	.194
58	2.233	.839	.476	.247
51	2.925	1.099	.623	.324

*** OSCAR ***

DRAFT = 12.0 FEET　　TRIM ANGLE = 0.00 DEG.
HEADING = 100.00 DEG.　　FORWARD SPEED = 0.00 KNOTS
ROLL GY. RADIUS =25.60 FEET　　PITCH GY. RADIUS = 145.0 FEET

V E S S E L　R E S P O N S E　O P E

OF BODY FPIER

ENCOUNTER FREQUENCY (RAD/SEC)	ENCOUNTER PERIOD (SEC)	SURGE/WAVE AMPL. AMPL.	SURGE/WAVE AMPL. PHASE	SWAY/WAVE AMPL. AMPL.	SWAY/WAVE AMPL. PHASE	HEAVE/WAVE AMPL. AMPL.	HEAVE/WAVE AMPL. PHASE
.2513	25.000	.1749	-100.3	.7863	90.7	.6696	-12.1
.3142	20.000	.1699	-106.5	.7744	91.3	.6741	-17.7
.3307	19.000	.1695	-108.5	.7768	91.6	.6760	-19.3
.3491	18.000	.1690	-110.8	.7799	91.9	.6786	-21.2
.3696	17.000	.1684	-113.6	.7837	92.0	.6824	-23.5
.3927	16.000	.1675	-117.0	.7889	92.4	.6878	-26.2
.4189	15.000	.1663	-121.1	.7949	92.7	.6954	-29.5
.4333	14.500	.1654	-123.5	.7980	92.8	.7004	-31.4
.4488	14.000	.1643	-126.2	.8013	92.9	.7063	-33.5
.4654	13.500	.1629	-129.2	.8048	93.2	.7131	-35.8
.4833	13.000	.1611	-132.6	.8081	93.4	.7213	-38.5
.5027	12.500	.1590	-136.4	.8113	93.3	.7311	-41.6
.5236	12.000	.1562	-140.8	.8139	93.5	.7423	-45.1
.5464	11.500	.1527	-145.8	.8159	93.5	.7556	-49.1
.5712	11.000	.1483	-151.5	.8166	93.2	.7710	-53.9
.5984	10.500	.1428	-158.2	.8152	93.1	.7885	-59.4
.6283	10.000	.1356	-166.1	.8112	92.4	.8084	-66.0
.6614	9.500	.1266	-175.5	.8032	91.6	.8301	-73.9
.6981	9.000	.1149	173.1	.7901	89.9	.8531	-83.6
.7392	8.500	.0999	159.0	.7714	87.7	.8749	-95.4
.7854	8.000	.0808	140.9	.7483	84.4	.8910	-110.4
.8378	7.500	.0569	115.8	.7299	79.5	.8902	-129.7
.8976	7.000	.0291	73.7	.7471	69.2	.8460	-154.8
.9666	6.500	.0139	-39.0	.5165	41.4	.7166	173.8
1.0472	6.000	.0216	-114.7	.2610	-20.4	.5188	138.7
1.1424	5.500	.0251	-137.4	.0497	28.5	.3159	105.3
1.2566	5.000	.0270	-172.6	.1268	65.6	.1965	64.9
1.3963	4.500	.0096	129.1	.1364	26.6	.1103	17.0
1.5708	4.000	.0134	-149.6	.0878	6.5	.0404	-.1
2.0944	3.000	.0040	-115.7	.0380	-141.7	.0038	-157.2

A-16

*** OSCAR ***

DATE 84/02/1

ANGLE = 0.00 DEG.
RD SPEED = 0.00 KNOTS
GY. RADIUS = 145.0 FEET

G-METACENTER = 32.4 FEET
WAVE STEEPNESS = 1/ 20
YAW GY. RADIUS = 145.0 FEET

R E S P O N S E   O P E R A T O R S

OF BODY FPIER

E AMPL.	HEAVE/ WAVE AMPL.		ROLL/ WAVE AMPL.		PITCH/ WAVE AMPL.		YAW/ WAVE AMPL.	
PHASE	AMPL.	PHASE	AMPL.	PHASE	AMPL.	PHASE	AMPL.	PHASE
90.7	.6696	-12.1	.0824	85.4	.0193	102.2	.0169	18.2
91.3	.6741	-17.7	.1242	83.5	.0260	80.1	.0226	3.9
91.6	.6760	-19.3	.1370	83.1	.0281	74.3	.0245	.7
91.9	.6786	-21.2	.1519	82.5	.0306	67.9	.0268	-2.9
92.0	.6824	-23.5	.1693	81.7	.0336	60.8	.0294	-6.9
92.4	.6878	-26.2	.1897	80.9	.0371	52.9	.0325	-10.9
92.7	.6954	-29.5	.2137	80.1	.0414	43.9	.0361	-15.4
92.8	.7004	-31.4	.2272	79.5	.0438	38.8	.0381	-17.9
92.9	.7063	-33.5	.2418	79.0	.0465	33.4	.0403	-20.5
93.2	.7131	-35.8	.2576	78.6	.0495	27.6	.0426	-23.0
93.4	.7213	-38.5	.2748	78.0	.0527	21.2	.0450	-26.0
93.3	.7311	-41.6	.2933	77.2	.0563	14.2	.0477	-29.4
93.5	.7423	-45.1	.3131	76.7	.0603	6.6	.0504	-32.6
93.5	.7556	-49.1	.3342	76.1	.0647	-1.9	.0532	-36.3
93.2	.7710	-53.9	.3568	75.3	.0695	-11.5	.0561	-40.8
93.1	.7885	-59.4	.3802	74.9	.0747	-22.1	.0590	-45.3
92.4	.8084	-66.0	.4050	74.2	.0805	-34.4	.0617	-51.0
91.6	.8301	-73.9	.4307	73.8	.0857	-48.4	.0641	-57.3
89.9	.8531	-83.6	.4588	73.5	.0933	-64.9	.0658	-65.2
87.7	.8749	-95.4	.4930	73.7	.1001	-84.5	.0665	-74.7
84.4	.8910	-110.4	.5471	74.6	.1064	-108.6	.0656	-86.7
79.5	.8902	-129.7	.6652	75.3	.1107	-139.1	.0623	-102.0
69.2	.8460	-154.8	.9819	66.0	.1087	-179.4	.0557	-121.9
41.4	.7166	173.8	.8306	13.8	.0894	125.4	.0454	-148.3
-20.4	.5188	138.7	1.0489	-58.2	.0469	56.1	.0304	176.1
-28.5	.3159	-105.3	.4311	-90.6	.0079	-22.9	.0113	-123.0
65.6	.1965	64.9	.1663	-110.4	.0098	74.3	.0068	-90.8
26.6	.1103	17.0	.0603	-124.2	.0096	-24.3	.0122	170.1
6.5	.0404	-.1	.0090	165.8	.0004	86.7	.0017	-6.1
-141.7	.0038	-157.2	.0117	-121.1	.0003	106.9	.0024	-45.4

2

*** OSCAR -

DRAFT = 12.0 FEET TRIM ANGLE = 0.00 DEG
HEADING = 100.00 DEG. FORWARD SPEED = 0.00 K
ROLL GY. RADIUS =25.60 FEET PITCH GY. RADIUS = 145.

S T A T I S T I C S O F M O T I O N S

OF BODY EPIrR

S E A S P E C T

ISSC --- SIGNIFICANT HEIGHT = 6.0 FEET

S I N G L E A M P L I T U

	SURGE -(FEET)-	SWAY -(FEET)-
ROOT MEAN SQUARE	.074	.751
AVE OF 1/3 HIGHEST	.147	1.503
AVE OF 1/10 HIGHEST	.188	1.916
AVE OF 1/100 HIGHEST	.246	2.510

S T A T I S T I C S O F A C C E L E R A T I O N

S I N G L E A M P

	SURGE (FEET /SEC**2)	SWAY (FEET /SEC**2)	HEAV (FEET /S
ROOT MEAN SQUARE	.052	.565	.7
AVE OF 1/3 HIGHEST	.103	1.129	1.4
AVE OF 1/10 HIGHEST	.132	1.440	1.8
AVE OF 1/100 HIGHEST	.172	1.886	2.4

A-17

```
*** OSCAR ***
---------------                                  DATE 84/02/1
NGLE =   0.00 DEG.                   G-METACENTER =   32.4 FEET
D SPEED =  0.00 KNOTS                WAVE STEEPNESS = 1/ 20
GY. RADIUS = 145.0 FEET              YAW GY. RADIUS = 145.0 FEET
```

M O T I O N S   I N   I R R E G U L A R   S E A S

OF BODY FPITR

S E A   S P E C T R U M

IGHT = 6.0 FEET   MEAN PERIOD = 5.5 SECONDS

E A M P L I T U D E   M O T I O N S

	SWAY	HEAVE	ROLL	PITCH	YAW
-	-(FEET)-	-(FEET)-	--(DEG)--	--(DEG)--	--(DEG)--
74	.751	.924	.957	.108	.063
47	1.503	1.848	1.913	.216	.126
88	1.916	2.356	2.440	.276	.161
46	2.510	3.086	3.195	.361	.211

E L E R A T I O N   I N   I R R E G U L A R   S E A S

I N G L E   A M P L I T U D E S

Y	HEAVE	ROLL	PITCH	YAW
EC**2)	(FEET /SEC**2)	(DEG/SEC**2)	(DEG/SEC**2)	(DEG/SEC**2)
65	.736	.894	.082	.048
29	1.472	1.788	.165	.095
40	1.877	2.280	.210	.122
86	2.459	2.987	.275	.159

2

APPENDIX B

CONNECTION ANALYSIS

Appendix B: FINGER/SPINE CONNECTION ANALYSIS

A description of the mathematical model of the connection is shown in Fig. B-1. The links are modelled as struts with an axial stiffness of 232,000 kips/ft. The shear key is also modelled as a strut, the stiffness of this strut can be assumed to have a value which represents the stiffness of the fendering at the key interface. In actuality the stiffness will not be linear and will be effective for a certain displacement equivalent to the maximum displacement the fender can withstand. The non-linearity of the stiffness will be neglected in this analysis. The effect of increased stiffness can be determined by varying the stiffness of the structural components relative to each other.

The model assumes that all vertical motions due to roll, pitch and heave at the connection interface are unconstrained. The links resist yaw and surge and the shear key resists sway. It is assumed that the tolerance and low friction at the shear key, and the hinges in the links will provide the freedom of movement in the vertical plane.

The most significant limitation is due to the assumption that neglects the effect of pitch. Pitching can cause axial deformation in the links which are placed at the deck level. The displacements at the deck level will be increased if the bottom of the finger pier pivots against the hull of the spine pier. This effect can be reduced by tapering the connection end of the finger pier, shown in Fig. 6. Or in other words the depth of the area bearing against the spine pier should be minimized.

From the summary of motions (p.A-6) it is evident that a wave heading of 110 degrees will impose the most severe forces on the links. The forces in the links are caused by surge and the yaw moment. The contribution from surge will not be very significant, but the yaw moment has to be resisted by a tension-compression couple in the links.

OSCAR could not be used to model the connection as described above. Another approach was taken to estimate the forces in the links. The theoretical justification of the approach taken to analyze the foces in the connection structure is as follows:

Virtual Mass Matrix

The virtual (added) mass and damping co-efficients for various frequencies for the finger pier are reported in the OSCAR output.

If the mass coefficients are multiplied by M_I.

M_I = inherant vessel mass

The results represent the diagonal of the virtual mass matrix evaluated 250 ft. from the centeroid of the vessel. The actual virtual mass matrix is nearly diagonal when evaluated at the centeroid. If:

M_i' = diagonal from OSCAR.
M_{0i} = diagonal at centeroid.

Surge : $M_{01} = M_1'$

Sway : $M_{02} = M_2'$

Heave : $M_{03} = M_3'$

Roll : $M_{04} = M_4'$

Pitch : $M_{05} + M_{03}(250)^2 = M_5'$

$M_{05} = M_5' - M_{03}(250)^2$

Yaw : $M_{06} + M_{02}(250)^2 = M_6'$

$M_{06} = M_6' - M_{02}(250)^2$

The computed mass properties at centeroid are included in Appendix B., P. B-13.

Inherent Mass Matrix

The inherent mass matrix is diagonal at the centeroid.

M = total vessel mass

M = displacement/g = $12 \times 80 \times 500 \times 0.064/32.2 = 954$ kip $\cdot s^2/ft$.

$M_1 = M = 954$ kip$\cdot s^2/ft$. surge

$M_2 = M = 954$ " " sway

$M_3 = M = 954$ " " heave

$M_4 = \frac{1}{12} M(30^2+80^2) = 580 \times 10^3$ kip$\cdot ft^2 \cdot s^2/ft$. roll

$M_5 = \frac{1}{12} M(500^2+30^2) = 642.3 \times 10^6$ ~ ~ pitch

$M_6 = \frac{1}{12} M(80^2+500^2) = 656.4 \times 10^6$ ~ ~ . yaw

Damping Matrix

Assume if the added damping coefficients reported in OSCAR are multiplied by M_I, the results represent the diagonal the damping matrix evaluated 250 feet from the centeroid of t' vessel. The actual damping matrix at the centeroid is nearly diagonal. If:

C_i' = diagonal from OSCAR.

C_{oi} = diagonal at centeroid.

Surge : $C_{o1} = C_1'$

Sway : $C_{o2} = C_2'$

Heave : $C_{o3} = C_3'$

Roll : $C_{o4} = C_4'$

Pitch : $C_{o5} = C_5' - C_{o3}(250)^2$

Yaw : $C_{o6} = C_6' - C_{o2}(250)^2$

Stiffness Matrix

At the centeroid of the vessel, the stiffness matrix is diagonal.

$K_{11} = 0$ surge.

$K_{22} = 0$ sway.

$K_{33} = 500 \times 80 \times 0.064 = 2560$ Kip/ft. heave.

$K_{44} = GM \times \text{displacement} = 32.4 \times 30720 = 995 \times 10^3$ Kip-ft. roll.

$K_{55} = 1/12 \times 80 \times 500^3 \times 0.064 = 53.3 \times 10^6$ Kip-ft pitch.

$K_{66} = 0$ Yaw.

Dyna:..ic Equations:

The eq:.ation of motion is:

$M\ddot{V} + C\dot{V} + KV = P$

where:

$V = V_c \cos(wt) + V_s \sin(wt)$

$V_c = V \cos(\theta)$

$V_s = V \sin(\theta)$

$\dot{V} = -wV_c \sin(wt) + wV_s \cos(wt)$

$\ddot{V} = -w^2 V_c \cos(wt) - w^2 V_s \sin(wt)$

$P = P_c \cos(wt) + P_s \sin(wt)$

$-w^2 M V_c + wCV_s + KV_c = P_c$

$-w^2 M V_s - wCV_c + KV_s = P_s$

express:.ng in complex numbers.

$-w^2 M V_c - iwCiV_s + KV_c = P_c$

$-w^2 M i V_s - iwCV_c + KiV_s = iP_s$

$$\left[-w^2 M - i w C + K\right] \qquad \left[V_c + i V_s\right] \qquad = \qquad \left[P_c + i P_s\right]$$

dynamic matrix	displ. vector	force vector
(6x6)	(6x1)	(6x1)

(*for each encounter frequency)

The dynamic matrix was evaluated at the joint end of the finger pier. Then for a heading of 110° the RAO's reported for the free-floating case were converted to V_c and V_s for the respective phase angles. These were multiplied with the dynamic matrix to obtain the force vectors. After the force vectors were computed the system of equations was solved for displacements, with the joint stiffness included in the stiffness component of the dynamic matrix.

The forces in the structural components were calculated from the computed displacement for each wave frequency. Then a force amplitude spectrum was obtained for an irregular sea with 6 feet significant wave height and a mean period of 5.5 seconds. Results were reported for average of 1/3 of spectral peak values times 1.92, to give a value which has a probabililty of being exceeded of 0.001.

A parametric study was done to determine the effect of varying the stiffness of the connection components relative to each other. The response of the system (RAO's) was calculated for the following structural stiffnesses:

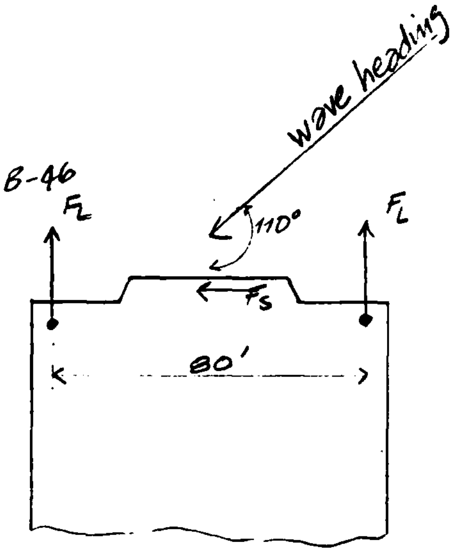
	Surge (k/f)	Sway (k/f)	Yaw (k-f/f)
Case 1	4.64E5	1.0E5	7.4E8
Case 2	2.32E5	1.0E5	3.712E8
Case 3	2.3E5	0.5E5	3.712E8
Case 4	∞	∞	∞

An insignificant difference was observed in the response for the above four trials see pp. B-36 to B-44. Hence, it can be concluded that for the range of stiffness and wave frequencies studied, the system was insignificant dynamic amplilfication and the forces generated in the connection components are essentially due to resisting the motions of the pier.

TY LIN INTERNATIONAL
STRUCTURAL ENGINEERING
315 Bay St., San Francisco, Ca. 94133

PROJECT:	ONR Navy Pier Concepts
ITEM:	Finger / spine Connection
DESIGN:	Connection loading
DATE:	

Connection loading:



Linear motion (wave) 110° heading FROM p. B-46

surge : $440/2 = 220^K$ / link
sway : 1137^K
Yaw : $\dfrac{323400^{K\text{-}F}}{80^F} = \pm 4040^K$ / link

Wave Drift: (110° heading) FROM p.___

surge : $7.7/2 = 3.85^K$ / link
sway : 42.7^K
Yaw : $\dfrac{10900^{K\text{-}F}}{80^F} = \pm 136^K$ / link.

Wind and current : (broadside)

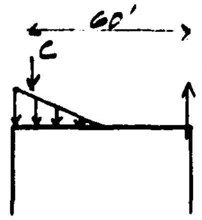
Total lateral force $= 30 + 62 = 92^K$ @ 333 FT. from conn.
(calculated on pp. A-1 & A-2)

$\therefore$ sway : $= 92^K$
Yaw : $= \dfrac{92 \times 333}{80} = \pm 383^K$ / link.

$\therefore F_S = 1137 + 42.7 + 92 = 1272$ kips

$F_L = 220 + 4 + 4040 + 136 + 383 \simeq 4800$ kips
Tension or comp.
in each link.

If finger pier is allowed to bear against the spine pier at the compression end. The moment arm will be reduced.



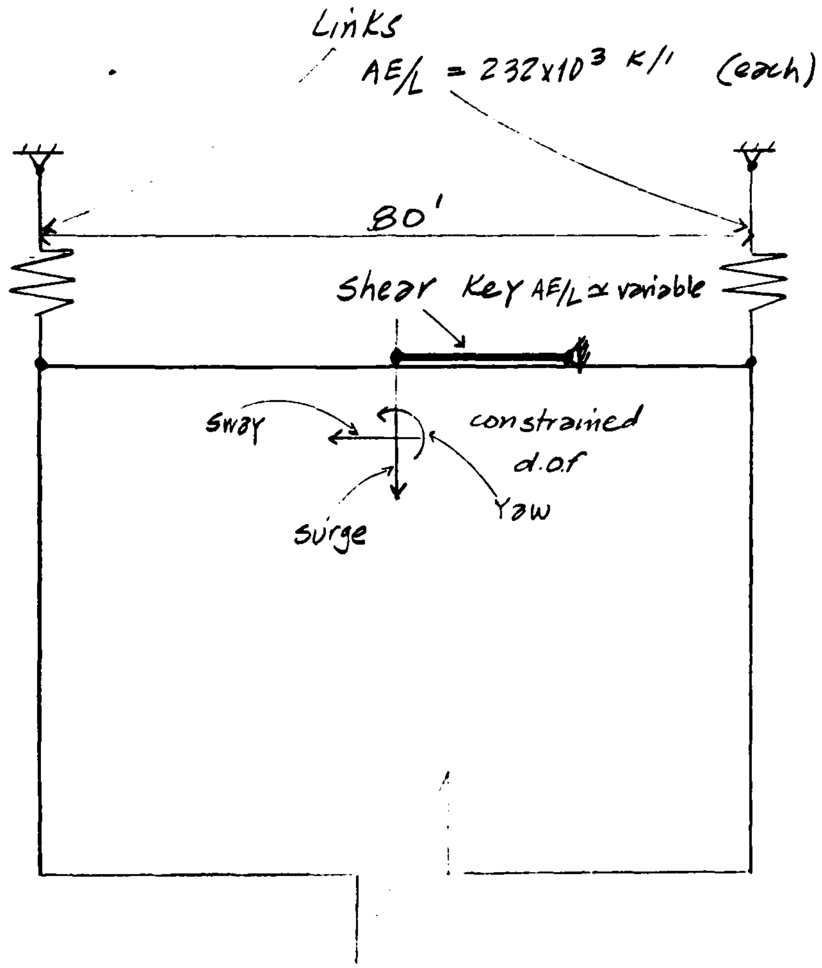
Assume moment arm is 60'

$\therefore F_L = 224 + (4559)\dfrac{80}{60} \simeq 6300$ kips
Tension.

T.Y. LIN INTERNATIONAL
STRUCTURAL ENGINEERING
315 Bay St., San Francisco, Ca. 94133

PROJECT:	ONR, Navy Pier Concepts
ITEM:	Finger / spine conn.
DESIGN:	Conn. Analytical model
DATE:	2/86 HTV
SHEET:	B-7
OF	
REVISION:	

Finger/spine connection: Analytical Model.



Note: all motions in vertical plane are unconstrained.

Fig. B-1

CONTENTS PAGE

*** OSCAR ***

DATE 84/02/2

DRIFT FORCE METHOD = FREQUENCY DOMAIN

SURGE DRIFT FACTOR = 1.000 SWAY DRIFT FACTOR = 1.000

WAVE DRIFT F O R C E S O N B O D Y FPIER FOR SEA HEADING = 110°

TYPE OF FORCE	FORCES (FEET)			MOMENTS (KIPS - FEET)		
	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
WIND	0.0	0.0	0.0	0.	0.	0.
WAVE	7.7	-42.7	-16.5	-514.	4215.	-10898.
CURRENT	.0	.0	0.0	-0.	0.	0.
APPLIED	0.0	0.0	0.0	0.	0.	0.
TOTAL	7.7	-42.7	-16.5	-514.	4215.	-10898.

COEFFICIENT VERIFICATION - VIRTUAL MASS COEFFICIENTS FOR 110° HEADING

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
0.2510	0.0434	0.3750	3.8341	26.5903	580.9455	181.8438
0.3140	0.0434	0.3931	3.2452	26.9235	534.4749	186.0253
0.3310	0.0434	0.4024	3.1210	27.1247	524.1480	188.2109
0.3490	0.0434	0.4092	2.9930	27.2469	513.2859	189.7797
0.3700	0.0434	0.4128	2.8609	27.2763	501.8358	190.6207
0.3930	0.0434	0.4211	2.7291	27.4037	490.1402	192.5225
0.4190	0.0434	0.4300	2.5954	27.5311	477.9800	194.5601
0.4330	0.0434	0.4328	2.5267	27.5458	471.6106	195.1736
0.4490	0.0434	0.4368	2.4592	27.5814	465.2771	196.0856
0.4650	0.0434	0.4427	2.3935	27.6483	459.0080	197.3986
0.4830	0.0434	0.4470	2.3261	27.6737	452.4993	198.3503
0.5030	0.0434	0.4496	2.2570	27.6578	445.7342	198.9460
0.5240	0.0434	0.4535	2.1934	27.6440	439.4028	199.7877
0.5460	0.0434	0.4559	2.1286	27.5920	432.8659	200.3213
0.5710	0.0434	0.4564	2.0624	27.4905	426.0876	200.4254
0.5980	0.0434	0.4539	2.0040	27.3034	420.0075	199.8947
0.6280	0.0434	0.4498	1.9422	27.0726	413.4803	198.9768
0.6610	0.0434	0.4386	1.8895	26.6858	407.8318	196.4976
0.6980	0.0434	0.4250	1.8349	26.2537	401.9000	193.4205
0.7390	0.0434	0.4011	1.7923	25.5880	397.2019	187.9106
0.7850	0.0434	0.3712	1.7546	24.8302	393.0046	180.7531
0.8380	0.0434	0.3343	1.7249	23.9575	389.6655	171.5365
0.8980	0.0434	0.2904	1.7077	23.0037	387.7215	159.8926
0.9670	0.0434	0.2418	1.7071	22.0523	387.6496	145.8831
1.0470	0.0434	0.1916	1.7253	21.2008	389.7071	129.8768
1.1420	0.0434	0.1433	1.7621	20.5260	393.8479	112.3184
1.2570	0.0434	0.0995	1.9255	20.1459	411.7032	93.5830
1.3960	0.0434	0.0628	2.1588	20.0510	435.9280	74.3735
1.5710	0.0434	0.0354	2.2974	20.2431	449.7080	55.7999
2.0940	0.0434	0.0119	2.2909	21.0149	449.0621	32.4328

COEFFICIENT VERIFICATION - DAMPING COEFFICIENTS

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
0.2510	0.0000	0.0016	0.9006	2.3815	79270.7031	140.5000
0.3140	0.0000	0.0049	1.0133	7.0537	89191.7969	428.9000
0.3310	0.0000	0.0070	1.0364	9.9071	91224.7031	613.6000
0.3490	0.0000	0.0091	1.0595	12.8482	93259.7969	804.1000
0.3700	0.0000	0.0113	1.0826	15.7893	95294.8984	994.5000
0.3930	0.0000	0.0156	1.1036	21.3721	97140.2969	1373.0000
0.4190	0.0000	0.0213	1.1231	28.6838	98861.5000	1874.4000
0.4330	0.0000	0.0241	1.1329	32.3396	99722.1016	2125.1001
0.4490	0.0000	0.0285	1.1409	37.6575	100427.0000	2505.5000
0.4650	0.0000	0.0347	1.1466	45.1498	100929.2031	3055.5000
0.4830	0.0000	0.0410	1.1523	52.6421	101431.0000	3605.5000
0.5030	0.0000	0.0472	1.1580	60.1344	101932.8984	4155.5000
0.5240	0.0000	0.0581	1.1581	72.2529	101943.1016	5113.6001
0.5460	0.0000	0.0697	1.1573	85.1342	101872.1016	6139.0000
0.5710	0.0000	0.0820	1.1558	98.4902	101736.2969	7214.8999
0.5980	0.0000	0.1006	1.1460	117.1492	100874.8984	8854.7998
0.6280	0.0000	0.1192	1.1362	135.8082	100013.5000	10494.5996
0.6610	0.0000	0.1440	1.1166	157.9806	98289.1016	12674.9004
0.6980	0.0000	0.1700	1.0948	180.7265	96368.8984	14963.7998
0.7390	0.0000	0.2010	1.0602	203.8295	93324.5000	17696.0996
0.7850	0.0000	0.2332	1.0175	224.7739	89563.5000	20529.4004
0.8380	0.0000	0.2661	0.9636	241.9033	84821.1016	23419.5996
0.8980	0.0000	0.2973	0.8952	251.9104	78798.6016	26169.0996
0.9670	0.0000	0.3240	0.8099	251.9838	71292.1016	28521.0996
1.0470	0.0000	0.3439	0.7072	241.0362	62247.8984	30268.1992
1.1420	0.0000	0.3554	0.5882	219.6012	51777.6016	31282.5000
1.2570	0.0000	0.3556	0.4676	187.6325	41159.8984	31301.6992
1.3960	0.0000	0.3445	0.3614	149.1666	31808.5996	30322.1992
1.5710	-0.0000	0.3202	0.2551	108.0222	22457.1992	28186.0000
2.0940	0.0000	0.2293	0.0427	40.0080	3754.5000	20183.5996

PROPERTIES AT CENTROID - VIRTUAL MASS / VESSEL MASS

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
0.2510	0.0434	0.3750	3.8341	707.0440	97866.3984	9629.6699
0.3140	0.0434	0.3931	3.2452	724.8749	82838.4375	10036.6621
0.3310	0.0434	0.4024	3.1210	735.7494	79668.6172	10273.3447
0.3490	0.0434	0.4092	2.9930	742.3936	76399.9141	10441.3320
0.3700	0.0434	0.4128	2.8609	743.9966	73032.9219	10536.2480
0.3930	0.0434	0.4211	2.7291	750.9628	69668.6563	10746.1670
0.4190	0.0434	0.4300	2.5954	757.9614	66252.4063	10978.6299
0.4330	0.0434	0.4328	2.5267	758.7711	64497.7891	11042.7314
0.4490	0.0434	0.4368	2.4592	760.7336	62782.7695	11149.5625
0.4650	0.0434	0.4427	2.3935	764.4285	61094.6016	11297.4639
0.4830	0.0434	0.4470	2.3261	765.8337	59374.3516	11405.3379
0.5030	0.0434	0.4496	2.2570	764.9539	57616.4805	11479.5137
0.5240	0.0434	0.4535	2.1934	764.1907	55987.3477	11571.3740
0.5460	0.0434	0.4559	2.1286	761.3184	54335.3945	11634.8721
0.5710	0.0434	0.4564	2.0624	755.7275	52650.6211	11645.3418
0.5980	0.0434	0.4539	2.0040	745.4756	51156.3242	11589.1377
0.6280	0.0434	0.4498	1.9422	732.9257	49578.4492	11479.2686
0.6610	0.0434	0.4386	1.8895	712.1320	48233.0156	11198.8076
0.6980	0.0434	0.4250	1.8349	689.2568	46842.3711	10848.9932
0.7390	0.0434	0.4011	1.7923	654.7457	45750.6133	10241.6436
0.7850	0.0434	0.3712	1.7546	616.5388	44790.1250	9471.6797
0.8380	0.0434	0.3343	1.7249	573.9619	44032.9453	8531.0186
0.8980	0.0434	0.2904	1.7077	529.1702	43596.7109	7415.6411
0.9670	0.0434	0.2418	1.7071	486.3039	43578.4492	6169.3784
1.0470	0.0434	0.1916	1.7253	449.4739	44040.3828	4892.9829
1.1420	0.0434	0.1433	1.7621	421.3166	44984.9180	3659.1724
1.2570	0.0434	0.0995	1.9255	405.8573	49155.7656	2539.0281
1.3960	0.0434	0.0628	2.1588	402.0426	55108.2422	1606.4170
1.5710	0.0434	0.0354	2.2974	409.7831	58649.8008	901.1288
2.0940	0.0434	0.0119	2.2909	441.6260	58475.5156	308.1364

PROPERTIES AT CENTROID - DAMPING / VESSEL MASS

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
0.2510	0.0434	0.3750	3.8341	707.0440	97866.3984	9629.6699
0.3140	0.0434	0.3931	3.2452	724.8749	82838.4375	10036.6621
0.3310	0.0434	0.4024	3.1210	735.7494	79668.6172	10273.3447
0.3490	0.0434	0.4092	2.9930	742.3936	76399.9141	10441.3320
0.3700	0.0434	0.4128	2.8609	743.9966	73032.9219	10536.2480
0.3930	0.0434	0.4211	2.7291	750.9628	69668.6563	10746.1670
0.4190	0.0434	0.4300	2.5954	757.9614	66252.4063	10978.6299
0.4330	0.0434	0.4328	2.5267	758.7711	64497.7891	11042.7314
0.4490	0.0434	0.4368	2.4592	760.7336	62782.7695	11149.5625
0.4650	0.0434	0.4427	2.3935	764.4285	61094.6016	11297.4639
0.4830	0.0434	0.4470	2.3261	765.8337	59374.3516	11405.3379
0.5030	0.0434	0.4496	2.2570	764.9539	57616.4805	11479.5137
0.5240	0.0434	0.4535	2.1934	764.1907	55987.3477	11571.3740
0.5460	0.0434	0.4559	2.1286	761.3184	54335.3945	11634.8721
0.5710	0.0434	0.4564	2.0624	755.7275	52650.6211	11645.3418
0.5980	0.0434	0.4539	2.0040	745.4756	51156.3242	11589.1377
0.6280	0.0434	0.4498	1.9422	732.9257	49578.4492	11479.2686
0.6610	0.0434	0.4386	1.8895	712.1320	48233.0156	11198.8076
0.6980	0.0434	0.4250	1.8349	689.2568	46842.3711	10848.9932
0.7390	0.0434	0.4011	1.7923	654.7457	45750.6133	10241.6436
0.7850	0.0434	0.3712	1.7546	616.5388	44790.1250	9471.6797
0.8380	0.0434	0.3343	1.7249	573.9619	44032.9453	8531.0186
0.8980	0.0434	0.2904	1.7077	529.1702	43596.7109	7415.6411
0.9670	0.0434	0.2418	1.7071	486.3039	43578.4492	6169.3784
1.0470	0.0434	0.1916	1.7253	449.4739	44040.3828	4892.9829
1.1420	0.0434	0.1433	1.7621	421.3166	44984.9180	3659.1724
1.2570	0.0434	0.0995	1.9255	405.8573	49155.7656	2539.0281
1.3960	0.0434	0.0628	2.1588	402.0426	55108.2422	1606.4170
1.5710	0.0434	0.0354	2.2974	409.7831	58649.8008	901.1288
2.0940	0.0434	0.0119	2.2909	441.6260	58475.5156	308.1364

DYNAMIC MATRICES

K(REAL) - FREQ = 0.251

-6.2714E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-8.2645E+01	0.0000E+00	0.0000E+00	0.0000E+00	-2.0661E+04
0.0000E+00	0.0000E+00	2.2694E+03	0.0000E+00	-5.6736E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	9.1627E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-5.6736E+05	0.0000E+00	1.8803E+08	0.0000E+00
0.0000E+00	-2.0661E+04	0.0000E+00	0.0000E+00	0.0000E+00	-7.0283E+06

K(IMAGINARY) - FREQ = 0.251

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-3.8314E-01	0.0000E+00	0.0000E+00	0.0000E+00	-9.5785E+01
0.0000E+00	0.0000E+00	-2.1566E+02	0.0000E+00	5.3915E+04	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-5.7028E+02	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	5.3915E+04	0.0000E+00	-1.8982E+07	0.0000E+00
0.0000E+00	-9.5785E+01	0.0000E+00	0.0000E+00	0.0000E+00	-3.3645E+04

K(REAL) - FREQ = 0.314

-9.8147E+01	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.3104E+02	0.0000E+00	0.0000E+00	0.0000E+00	-3.2760E+04
0.0000E+00	0.0000E+00	2.1607E+03	0.0000E+00	-5.4017E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	8.6992E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-5.4017E+05	0.0000E+00	1.7862E+08	0.0000E+00
0.0000E+00	-3.2760E+04	0.0000E+00	0.0000E+00	0.0000E+00	-1.1144E+07

K(IMAGINARY) - FREQ = 0.314

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.4679E+00	0.0000E+00	0.0000E+00	0.0000E+00	-3.6697E+02
0.0000E+00	0.0000E+00	-3.0355E+02	0.0000E+00	7.5888E+04	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-2.1131E+03	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	7.5888E+04	0.0000E+00	-2.6719E+07	0.0000E+00
0.0000E+00	-3.6697E+02	0.0000E+00	0.0000E+00	0.0000E+00	-1.2848E+05

K(REAL) - FREQ = 0.331

-1.0906E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.4659E+02	0.0000E+00	0.0000E+00	0.0000E+00	-3.6647E+04
0.0000E+00	0.0000E+00	2.1293E+03	0.0000E+00	-5.3231E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	8.5484E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-5.3231E+05	0.0000E+00	1.7590E+08	0.0000E+00
0.0000E+00	-3.6647E+04	0.0000E+00	0.0000E+00	0.0000E+00	-1.2469E+07

K(IMAGINARY) - FREQ = 0.331

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-2.2105E+00	0.0000E+00	0.0000E+00	0.0000E+00	-5.5263E+02
0.0000E+00	0.0000E+00	-3.2728E+02	0.0000E+00	8.1820E+04	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-3.1285E+03	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	8.1820E+04	0.0000E+00	-2.8808E+07	0.0000E+00

0.0000E+00	-5.5263E+02	0.0000E+00	0.0000E+00	0.0000E+00	-1.9377E+05

K(REAL) - FREQ = 0.349

-1.2125E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.6375E+02	0.0000E+00	0.0000E+00	0.0000E+00	-4.0938E+04
0.0000E+00	0.0000E+00	2.0960E+03	0.0000E+00	-5.2400E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	8.3837E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-5.2400E+05	0.0000E+00	1.7303E+08	0.0000E+00
0.0000E+00	-4.0938E+04	0.0000E+00	0.0000E+00	0.0000E+00	-1.3931E+07

K(IMAGINARY) - FREQ = 0.349

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-3.0299E+00	0.0000E+00	0.0000E+00	0.0000E+00	-7.5748E+02
0.0000E+00	0.0000E+00	-3.5277E+02	0.0000E+00	8.8193E+04	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-4.2779E+03	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	8.8193E+04	0.0000E+00	-3.1052E+07	0.0000E+00
0.0000E+00	-7.5748E+02	0.0000E+00	0.0000E+00	0.0000E+00	-2.6773E+05

K(REAL) - FREQ = 0.370

-1.3628E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.8452E+02	0.0000E+00	0.0000E+00	0.0000E+00	-4.6131E+04
0.0000E+00	0.0000E+00	2.0557E+03	0.0000E+00	-5.1393E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	8.1870E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-5.1393E+05	0.0000E+00	1.6955E+08	0.0000E+00
0.0000E+00	-4.6131E+04	0.0000E+00	0.0000E+00	0.0000E+00	-1.5699E+07

K(IMAGINARY) - FREQ = 0.370

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-3.9888E+00	0.0000E+00	0.0000E+00	0.0000E+00	-9.9721E+02
0.0000E+00	0.0000E+00	-3.8215E+02	0.0000E+00	9.5538E+04	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-5.5735E+03	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	9.5538E+04	0.0000E+00	-3.3639E+07	0.0000E+00
0.0000E+00	-9.9721E+02	0.0000E+00	0.0000E+00	0.0000E+00	-3.5105E+05

K(REAL) - FREQ = 0.393

-1.5375E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-2.0940E+02	0.0000E+00	0.0000E+00	0.0000E+00	-5.2350E+04
0.0000E+00	0.0000E+00	2.0105E+03	0.0000E+00	-5.0263E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	7.9504E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-5.0263E+05	0.0000E+00	1.6564E+08	0.0000E+00
0.0000E+00	-5.2350E+04	0.0000E+00	0.0000E+00	0.0000E+00	-1.7819E+07

K(IMAGINARY) - FREQ = 0.393

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-5.8490E+00	0.0000E+00	0.0000E+00	0.0000E+00	-1.4623E+03
0.0000E+00	0.0000E+00	-4.1378E+02	0.0000E+00	1.0345E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-8.0132E+03	0.0000E+00	0.0000E+00

0.0000E+00	-5.5263E+02	0.0000E+00	0.0000E+00	0.0000E+00	-1.9377E+05

K(REAL) - FREQ = 0.349

-1.2125E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.6375E+02	0.0000E+00	0.0000E+00	0.0000E+00	-4.0938E+04
0.0000E+00	0.0000E+00	2.0960E+03	0.0000E+00	-5.2400E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	8.3837E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-5.2400E+05	0.0000E+00	1.7303E+08	0.0000E+00
0.0000E+00	-4.0938E+04	0.0000E+00	0.0000E+00	0.0000E+00	-1.3931E+07

K(IMAGINARY) - FREQ = 0.349

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-3.0299E+00	0.0000E+00	0.0000E+00	0.0000E+00	-7.5748E+02
0.0000E+00	0.0000E+00	-3.5277E+02	0.0000E+00	8.8193E+04	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-4.2779E+03	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	8.8193E+04	0.0000E+00	-3.1052E+07	0.0000E+00
0.0000E+00	-7.5748E+02	0.0000E+00	0.0000E+00	0.0000E+00	-2.6773E+05

K(REAL) - FREQ = 0.370

-1.3628E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.8452E+02	0.0000E+00	0.0000E+00	0.0000E+00	-4.6131E+04
0.0000E+00	0.0000E+00	2.0557E+03	0.0000E+00	-5.1393E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	8.1870E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-5.1393E+05	0.0000E+00	1.6955E+08	0.0000E+00
0.0000E+00	-4.6131E+04	0.0000E+00	0.0000E+00	0.0000E+00	-1.5699E+07

K(IMAGINARY) - FREQ = 0.370

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-3.9888E+00	0.0000E+00	0.0000E+00	0.0000E+00	-9.9721E+02
0.0000E+00	0.0000E+00	-3.8215E+02	0.0000E+00	9.5538E+04	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-5.5735E+03	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	9.5538E+04	0.0000E+00	-3.3639E+07	0.0000E+00
0.0000E+00	-9.9721E+02	0.0000E+00	0.0000E+00	0.0000E+00	-3.5105E+05

K(REAL) - FREQ = 0.393

-1.5375E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-2.0940E+02	0.0000E+00	0.0000E+00	0.0000E+00	-5.2350E+04
0.0000E+00	0.0000E+00	2.0105E+03	0.0000E+00	-5.0263E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	7.9504E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-5.0263E+05	0.0000E+00	1.6564E+08	0.0000E+00
0.0000E+00	-5.2350E+04	0.0000E+00	0.0000E+00	0.0000E+00	-1.7819E+07

K(IMAGINARY) - FREQ = 0.393

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-5.8490E+00	0.0000E+00	0.0000E+00	0.0000E+00	-1.4623E+03
0.0000E+00	0.0000E+00	-4.1378E+02	0.0000E+00	1.0345E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-8.0132E+03	0.0000E+00	0.0000E+00

0.0000E+00	0.0000E+00	1.0345E+05	0.0000E+00	-3.6421E+07	0.0000E+00
0.0000E+00	-1.4623E+03	0.0000E+00	0.0000E+00	0.0000E+00	-5.1479E+05

K(REAL) - FREQ = 0.419

-1.7476E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-2.3951E+02	0.0000E+00	0.0000E+00	0.0000E+00	-5.9878E+04
0.0000E+00	0.0000E+00	1.9578E+03	0.0000E+00	-4.8945E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	7.6649E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-4.8945E+05	0.0000E+00	1.6110E+08	0.0000E+00
0.0000E+00	-5.9878E+04	0.0000E+00	0.0000E+00	0.0000E+00	-2.0387E+07

K(IMAGINARY) - FREQ = 0.419

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-8.5145E+00	0.0000E+00	0.0000E+00	0.0000E+00	-2.1286E+03
0.0000E+00	0.0000E+00	-4.4895E+02	0.0000E+00	1.1224E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-1.1466E+04	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.1224E+05	0.0000E+00	-3.9519E+07	0.0000E+00
0.0000E+00	-2.1286E+03	0.0000E+00	0.0000E+00	0.0000E+00	-7.4928E+05

K(REAL) - FREQ = 0.433

-1.8663E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-2.5629E+02	0.0000E+00	0.0000E+00	0.0000E+00	-6.4072E+04
0.0000E+00	0.0000E+00	1.9292E+03	0.0000E+00	-4.8229E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	7.5079E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-4.8229E+05	0.0000E+00	1.5863E+08	0.0000E+00
0.0000E+00	-6.4072E+04	0.0000E+00	0.0000E+00	0.0000E+00	-2.1815E+07

K(IMAGINARY) - FREQ = 0.433

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-9.9557E+00	0.0000E+00	0.0000E+00	0.0000E+00	-2.4889E+03
0.0000E+00	0.0000E+00	-4.6800E+02	0.0000E+00	1.1700E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-1.3359E+04	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.1700E+05	0.0000E+00	-4.1195E+07	0.0000E+00
0.0000E+00	-2.4889E+03	0.0000E+00	0.0000E+00	0.0000E+00	-8.7787E+05

K(REAL) - FREQ = 0.449

-2.0068E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-2.7635E+02	0.0000E+00	0.0000E+00	0.0000E+00	-6.9087E+04
0.0000E+00	0.0000E+00	1.8947E+03	0.0000E+00	-4.7367E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	7.3201E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-4.7367E+05	0.0000E+00	1.5565E+08	0.0000E+00
0.0000E+00	-6.9087E+04	0.0000E+00	0.0000E+00	0.0000E+00	-2.3526E+07

K(IMAGINARY) - FREQ = 0.449

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.2208E+01	0.0000E+00	0.0000E+00	0.0000E+00	-3.0521E+03
0.0000E+00	0.0000E+00	-4.8872E+02	0.0000E+00	1.2218E+05	0.0000E+00

0.0000E+00	0.0000E+00	0.0000E+00	-1.6131E+04	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.2218E+05	0.0000E+00	-4.3019E+07	0.0000E+00
0.0000E+00	-3.0521E+03	0.0000E+00	0.0000E+00	0.0000E+00	-1.0733E+06

K(REAL) - FREQ = 0.465

-2.1524E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-2.9761E+02	0.0000E+00	0.0000E+00	0.0000E+00	-7.4402E+04
0.0000E+00	0.0000E+00	1.8600E+03	0.0000E+00	-4.6499E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	7.1215E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-4.6499E+05	0.0000E+00	1.5267E+08	0.0000E+00
0.0000E+00	-7.4402E+04	0.0000E+00	0.0000E+00	0.0000E+00	-2.5339E+07

K(IMAGINARY) - FREQ = 0.465

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.5394E+01	0.0000E+00	0.0000E+00	0.0000E+00	-3.8485E+03
0.0000E+00	0.0000E+00	-5.0866E+02	0.0000E+00	1.2717E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-2.0030E+04	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.2717E+05	0.0000E+00	-4.4775E+07	0.0000E+00
0.0000E+00	-3.8485E+03	0.0000E+00	0.0000E+00	0.0000E+00	-1.3555E+06

K(REAL) - FREQ = 0.483

-2.3223E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-3.2205E+02	0.0000E+00	0.0000E+00	0.0000E+00	-8.0513E+04
0.0000E+00	0.0000E+00	1.8197E+03	0.0000E+00	-4.5493E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	6.8948E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-4.5493E+05	0.0000E+00	1.4920E+08	0.0000E+00
0.0000E+00	-8.0513E+04	0.0000E+00	0.0000E+00	0.0000E+00	-2.7422E+07

K(IMAGINARY) - FREQ = 0.483

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.8893E+01	0.0000E+00	0.0000E+00	0.0000E+00	-4.7232E+03
0.0000E+00	0.0000E+00	-5.3098E+02	0.0000E+00	1.3274E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-2.4257E+04	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.3274E+05	0.0000E+00	-4.6739E+07	0.0000E+00
0.0000E+00	-4.7232E+03	0.0000E+00	0.0000E+00	0.0000E+00	-1.6614E+06

K(REAL) - FREQ = 0.503

-2.5186E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-3.4990E+02	0.0000E+00	0.0000E+00	0.0000E+00	-8.7476E+04
0.0000E+00	0.0000E+00	1.7738E+03	0.0000E+00	-4.4346E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	6.6384E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-4.4346E+05	0.0000E+00	1.4524E+08	0.0000E+00
0.0000E+00	-8.7476E+04	0.0000E+00	0.0000E+00	0.0000E+00	-2.9797E+07

K(IMAGINARY) - FREQ = 0.503

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-2.2650E+01	0.0000E+00	0.0000E+00	0.0000E+00	-5.6626E+03

0.0000E+00	0.0000E+00	-5.5570E+02	0.0000E+00	1.3893E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-2.8857E+04	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.3893E+05	0.0000E+00	-4.8916E+07	0.0000E+00
0.0000E+00	-5.6626E+03	0.0000E+00	0.0000E+00	0.0000E+00	-1.9941E+06

K(REAL) - FREQ = 0.524

-2.7332E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-3.8075E+02	0.0000E+00	0.0000E+00	0.0000E+00	-9.5188E+04
0.0000E+00	0.0000E+00	1.7235E+03	0.0000E+00	-4.3087E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	6.3579E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-4.3087E+05	0.0000E+00	1.4091E+08	0.0000E+00
0.0000E+00	-9.5188E+04	0.0000E+00	0.0000E+00	0.0000E+00	-3.2425E+07

K(IMAGINARY) - FREQ = 0.524

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-2.9045E+01	0.0000E+00	0.0000E+00	0.0000E+00	-7.2613E+03
0.0000E+00	0.0000E+00	-5.7895E+02	0.0000E+00	1.4474E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-3.6120E+04	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.4474E+05	0.0000E+00	-5.0963E+07	0.0000E+00
0.0000E+00	-7.2613E+03	0.0000E+00	0.0000E+00	0.0000E+00	-2.5564E+06

K(REAL) - FREQ = 0.546

-2.9676E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-4.1408E+02	0.0000E+00	0.0000E+00	0.0000E+00	-1.0352E+05
0.0000E+00	0.0000E+00	1.6702E+03	0.0000E+00	-4.1755E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	6.0578E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-4.1755E+05	0.0000E+00	1.3632E+08	0.0000E+00
0.0000E+00	-1.0352E+05	0.0000E+00	0.0000E+00	0.0000E+00	-3.5266E+07

K(IMAGINARY) - FREQ = 0.546

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-3.6307E+01	0.0000E+00	0.0000E+00	0.0000E+00	-9.0768E+03
0.0000E+00	0.0000E+00	-6.0284E+02	0.0000E+00	1.5071E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-4.4347E+04	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.5071E+05	0.0000E+00	-5.3066E+07	0.0000E+00
0.0000E+00	-9.0768E+03	0.0000E+00	0.0000E+00	0.0000E+00	-3.1978E+06

K(REAL) - FREQ = 0.571

-3.2456E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-4.5302E+02	0.0000E+00	0.0000E+00	0.0000E+00	-1.1326E+05
0.0000E+00	0.0000E+00	1.6074E+03	0.0000E+00	-4.0186E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	5.7103E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-4.0186E+05	0.0000E+00	1.3092E+08	0.0000E+00
0.0000E+00	-1.1326E+05	0.0000E+00	0.0000E+00	0.0000E+00	-3.8582E+07

K(IMAGINARY) - FREQ = 0.571

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

0.0000E+00	-4.4670E+01	0.0000E+00	0.0000E+00	0.0000E+00	-1.1167E+04
0.0000E+00	0.0000E+00	-6.2963E+02	0.0000E+00	1.5741E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-5.3653E+04	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.5741E+05	0.0000E+00	-5.5421E+07	0.0000E+00
0.0000E+00	-1.1167E+04	0.0000E+00	0.0000E+00	0.0000E+00	-3.9304E+06

K(REAL) - FREQ = 0.598

-3.5597E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-4.9602E+02	0.0000E+00	0.0000E+00	0.0000E+00	-1.2401E+05
0.0000E+00	0.0000E+00	1.5351E+03	0.0000E+00	-3.8378E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	5.3345E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-3.8378E+05	0.0000E+00	1.2469E+08	0.0000E+00
0.0000E+00	-1.2401E+05	0.0000E+00	0.0000E+00	0.0000E+00	-4.2245E+07

K(IMAGINARY) - FREQ = 0.598

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-5.7394E+01	0.0000E+00	0.0000E+00	0.0000E+00	-1.4348E+04
0.0000E+00	0.0000E+00	-6.5381E+02	0.0000E+00	1.6345E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-6.6835E+04	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.6345E+05	0.0000E+00	-5.7551E+07	0.0000E+00
0.0000E+00	-1.4348E+04	0.0000E+00	0.0000E+00	0.0000E+00	-5.0518E+06

K(REAL) - FREQ = 0.628

-3.9259E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-5.4550E+02	0.0000E+00	0.0000E+00	0.0000E+00	-1.3637E+05
0.0000E+00	0.0000E+00	1.4530E+03	0.0000E+00	-3.6324E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	4.9067E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-3.6324E+05	0.0000E+00	1.1762E+08	0.0000E+00
0.0000E+00	-1.3637E+05	0.0000E+00	0.0000E+00	0.0000E+00	-4.6452E+07

K(IMAGINARY) - FREQ = 0.628

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-7.1417E+01	0.0000E+00	0.0000E+00	0.0000E+00	-1.7854E+04
0.0000E+00	0.0000E+00	-6.8074E+02	0.0000E+00	1.7018E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-8.1368E+04	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.7018E+05	0.0000E+00	-5.9922E+07	0.0000E+00
0.0000E+00	-1.7854E+04	0.0000E+00	0.0000E+00	0.0000E+00	-6.2877E+06

K(REAL) - FREQ = 0.661

-4.3493E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-5.9966E+02	0.0000E+00	0.0000E+00	0.0000E+00	-1.4992E+05
0.0000E+00	0.0000E+00	1.3555E+03	0.0000E+00	-3.3889E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	4.4491E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-3.3889E+05	0.0000E+00	1.0923E+08	0.0000E+00
0.0000E+00	-1.4992E+05	0.0000E+00	0.0000E+00	0.0000E+00	-5.1054E+07

K(IMAGINARY) - FREQ = 0.661

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-9.0809E+01	0.0000E+00	0.0000E+00	0.0000E+00	-2.2702E+04
0.0000E+00	0.0000E+00	-7.0415E+02	0.0000E+00	1.7604E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-9.9626E+04	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.7604E+05	0.0000E+00	-6.1983E+07	0.0000E+00
0.0000E+00	-2.2702E+04	0.0000E+00	0.0000E+00	0.0000E+00	-7.9930E+06

K(REAL) - FREQ = 0.698

-4.8498E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-6.6236E+02	0.0000E+00	0.0000E+00	0.0000E+00	-1.6559E+05
0.0000E+00	0.0000E+00	1.2423E+03	0.0000E+00	-3.1058E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	3.9219E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-3.1058E+05	0.0000E+00	9.9486E+07	0.0000E+00
0.0000E+00	-1.6559E+05	0.0000E+00	0.0000E+00	0.0000E+00	-5.6371E+07

K(IMAGINARY) - FREQ = 0.698

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.1321E+02	0.0000E+00	0.0000E+00	0.0000E+00	-2.8302E+04
0.0000E+00	0.0000E+00	-7.2905E+02	0.0000E+00	1.8226E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-1.2035E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.8226E+05	0.0000E+00	-6.4174E+07	0.0000E+00
0.0000E+00	-2.8302E+04	0.0000E+00	0.0000E+00	0.0000E+00	-9.9647E+06

K(REAL) - FREQ = 0.739

-5.4363E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-7.3000E+02	0.0000E+00	0.0000E+00	0.0000E+00	-1.8250E+05
0.0000E+00	0.0000E+00	1.1052E+03	0.0000E+00	-2.7629E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	3.3724E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-2.7629E+05	0.0000E+00	8.7675E+07	0.0000E+00
0.0000E+00	-1.8250E+05	0.0000E+00	0.0000E+00	0.0000E+00	-6.2094E+07

K(IMAGINARY) - FREQ = 0.739

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.4171E+02	0.0000E+00	0.0000E+00	0.0000E+00	-3.5428E+04
0.0000E+00	0.0000E+00	-7.4748E+02	0.0000E+00	1.8687E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-1.4371E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.8687E+05	0.0000E+00	-6.5797E+07	0.0000E+00
0.0000E+00	-3.5428E+04	0.0000E+00	0.0000E+00	0.0000E+00	-1.2476E+07

K(REAL) - FREQ = 0.785

-6.1342E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-8.0613E+02	0.0000E+00	0.0000E+00	0.0000E+00	-2.0153E+05
0.0000E+00	0.0000E+00	9.4057E+02	0.0000E+00	-2.3514E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	2.7522E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-2.3514E+05	0.0000E+00	7.3494E+07	0.0000E+00
0.0000E+00	-2.0153E+05	0.0000E+00	0.0000E+00	0.0000E+00	-6.8513E+07

K(IMAGINARY) - FREQ = 0.785

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.7465E+02	0.0000E+00	0.0000E+00	0.0000E+00	-4.3662E+04
0.0000E+00	0.0000E+00	-7.6203E+02	0.0000E+00	1.9051E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-1.6834E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.9051E+05	0.0000E+00	-6.7076E+07	0.0000E+00
0.0000E+00	-4.3662E+04	0.0000E+00	0.0000E+00	0.0000E+00	-1.5375E+07

K(REAL) - FREQ = 0.838

-6.9704E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-8.9394E+02	0.0000E+00	0.0000E+00	0.0000E+00	-2.2348E+05
0.0000E+00	0.0000E+00	7.3441E+02	0.0000E+00	-1.8360E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	2.0323E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-1.8360E+05	0.0000E+00	5.5725E+07	0.0000E+00
0.0000E+00	-2.2348E+05	0.0000E+00	0.0000E+00	0.0000E+00	-7.5902E+07

K(IMAGINARY) - FREQ = 0.838

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-2.1274E+02	0.0000E+00	0.0000E+00	0.0000E+00	-5.3186E+04
0.0000E+00	0.0000E+00	-7.7038E+02	0.0000E+00	1.9260E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-1.9340E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.9260E+05	0.0000E+00	-6.7813E+07	0.0000E+00
0.0000E+00	-5.3186E+04	0.0000E+00	0.0000E+00	0.0000E+00	-1.8724E+07

K(REAL) - FREQ = 0.898

-8.0273E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-9.9276E+02	0.0000E+00	0.0000E+00	0.0000E+00	-2.4819E+05
0.0000E+00	0.0000E+00	4.7686E+02	0.0000E+00	-1.1921E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	1.2020E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-1.1921E+05	0.0000E+00	3.3511E+07	0.0000E+00
0.0000E+00	-2.4819E+05	0.0000E+00	0.0000E+00	0.0000E+00	-8.4191E+07

K(IMAGINARY) - FREQ = 0.898

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-2.5470E+02	0.0000E+00	0.0000E+00	0.0000E+00	-6.3676E+04
0.0000E+00	0.0000E+00	-7.6694E+02	0.0000E+00	1.9174E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-2.1582E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.9174E+05	0.0000E+00	-6.7509E+07	0.0000E+00
0.0000E+00	-6.3676E+04	0.0000E+00	0.0000E+00	0.0000E+00	-2.2420E+07

K(REAL) - FREQ = 0.967

-9.3083E+02	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.1078E+03	0.0000E+00	0.0000E+00	0.0000E+00	-2.7696E+05
0.0000E+00	0.0000E+00	1.4497E+02	0.0000E+00	-3.6242E+04	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	1.8792E+04	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	-3.6242E+04	0.0000E+00	4.8647E+06	0.0000E+00
0.0000E+00	-2.7696E+05	0.0000E+00	0.0000E+00	0.0000E+00	-9.3804E+07

K(IMAGINARY) - FREQ = 0.967

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-2.9891E+02	0.0000E+00	0.0000E+00	0.0000E+00	-7.4727E+04
0.0000E+00	0.0000E+00	-7.4718E+02	0.0000E+00	1.8679E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-2.3247E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.8679E+05	0.0000E+00	-6.5771E+07	0.0000E+00
0.0000E+00	-7.4727E+04	0.0000E+00	0.0000E+00	0.0000E+00	-2.6312E+07

K(REAL) - FREQ = 1.047

-1.0912E+03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.2462E+03	0.0000E+00	0.0000E+00	0.0000E+00	-3.1155E+05
0.0000E+00	0.0000E+00	-2.9019E+02	0.0000E+00	7.2546E+04	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-1.1095E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	7.2546E+04	0.0000E+00	-3.2728E+07	0.0000E+00
0.0000E+00	-3.1155E+05	0.0000E+00	0.0000E+00	0.0000E+00	-1.0535E+08

K(IMAGINARY) - FREQ = 1.047

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-3.4351E+02	0.0000E+00	0.0000E+00	0.0000E+00	-8.5878E+04
0.0000E+00	0.0000E+00	-7.0641E+02	0.0000E+00	1.7660E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-2.4077E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.7660E+05	0.0000E+00	-6.2178E+07	0.0000E+00
0.0000E+00	-8.5878E+04	0.0000E+00	0.0000E+00	0.0000E+00	-3.0234E+07

K(REAL) - FREQ = 1.142

-1.2982E+03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.4225E+03	0.0000E+00	0.0000E+00	0.0000E+00	-3.5563E+05
0.0000E+00	0.0000E+00	-8.7666E+02	0.0000E+00	2.1917E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-2.8578E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	2.1917E+05	0.0000E+00	-8.3444E+07	0.0000E+00
0.0000E+00	-3.5563E+05	0.0000E+00	0.0000E+00	0.0000E+00	-1.2005E+08

K(IMAGINARY) - FREQ = 1.142

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-3.8721E+02	0.0000E+00	0.0000E+00	0.0000E+00	-9.6803E+04
0.0000E+00	0.0000E+00	-6.4085E+02	0.0000E+00	1.6021E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-2.3926E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.6021E+05	0.0000E+00	-5.6412E+07	0.0000E+00
0.0000E+00	-9.6803E+04	0.0000E+00	0.0000E+00	0.0000E+00	-3.4083E+07

K(REAL) - FREQ = 1.257

-1.5728E+03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.6574E+03	0.0000E+00	0.0000E+00	0.0000E+00	-4.1435E+05
0.0000E+00	0.0000E+00	-1.8500E+03	0.0000E+00	4.6249E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-5.3349E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	4.6249E+05	0.0000E+00	-1.6791E+08	0.0000E+00
0.0000E+00	-4.1435E+05	0.0000E+00	0.0000E+00	0.0000E+00	-1.3962E+08

K(IMAGINARY) - FREQ = 1.257

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-4.2644E+02	0.0000E+00	0.0000E+00	0.0000E+00	-1.0661E+05
0.0000E+00	0.0000E+00	-5.6076E+02	0.0000E+00	1.4019E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-2.2501E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.4019E+05	0.0000E+00	-4.9360E+07	0.0000E+00
0.0000E+00	-1.0661E+05	0.0000E+00	0.0000E+00	0.0000E+00	-3.7538E+07

K(REAL) - FREQ = 1.396

-1.9399E+03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-1.9760E+03	0.0000E+00	0.0000E+00	0.0000E+00	-4.9400E+05
0.0000E+00	0.0000E+00	-3.3130E+03	0.0000E+00	8.2824E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-8.8321E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	8.2824E+05	0.0000E+00	-2.9506E+08	0.0000E+00
0.0000E+00	-4.9400E+05	0.0000E+00	0.0000E+00	0.0000E+00	-1.6621E+08

K(IMAGINARY) - FREQ = 1.396

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-4.5882E+02	0.0000E+00	0.0000E+00	0.0000E+00	-1.1470E+05
0.0000E+00	0.0000E+00	-4.8133E+02	0.0000E+00	1.2033E+05	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-1.9867E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.2033E+05	0.0000E+00	-4.2364E+07	0.0000E+00
0.0000E+00	-1.1470E+05	0.0000E+00	0.0000E+00	0.0000E+00	-4.0384E+07

K(REAL) - FREQ = 1.571

-2.4568E+03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-2.4380E+03	0.0000E+00	0.0000E+00	0.0000E+00	-6.0949E+05
0.0000E+00	0.0000E+00	-5.2041E+03	0.0000E+00	1.3010E+06	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-1.4019E+06	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	1.3010E+06	0.0000E+00	-4.5925E+08	0.0000E+00
0.0000E+00	-6.0949E+05	0.0000E+00	0.0000E+00	0.0000E+00	-2.0480E+08

K(IMAGINARY) - FREQ = 1.571

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-4.7991E+02	0.0000E+00	0.0000E+00	0.0000E+00	-1.1998E+05
0.0000E+00	0.0000E+00	-3.8234E+02	0.0000E+00	9.5586E+04	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-1.6190E+05	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	9.5586E+04	0.0000E+00	-3.3659E+07	0.0000E+00
0.0000E+00	-1.1998E+05	0.0000E+00	0.0000E+00	0.0000E+00	-4.2245E+07

K(REAL) - FREQ = 2.094

-4.3649E+03	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-4.2331E+03	0.0000E+00	0.0000E+00	0.0000E+00	-1.0583E+06
0.0000E+00	0.0000E+00	-1.1207E+04	0.0000E+00	2.8017E+06	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-3.3970E+06	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	2.8017E+06	0.0000E+00	-9.7918E+08	0.0000E+00
0.0000E+00	-1.0583E+06	0.0000E+00	0.0000E+00	0.0000E+00	-3.5524E+08

K(IMAGINARY) - FREQ = 2.094

0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.0000E+00	-4.5809E+02	0.0000E+00	0.0000E+00	0.0000E+00	-1.1452E+05
0.0000E+00	0.0000E+00	-8.5304E+01	0.0000E+00	2.1326E+04	0.0000E+00
0.0000E+00	0.0000E+00	0.0000E+00	-7.9926E+04	0.0000E+00	0.0000E+00
0.0000E+00	0.0000E+00	2.1326E+04	0.0000E+00	-7.5006E+06	0.0000E+00
0.0000E+00	-1.1452E+05	0.0000E+00	0.0000E+00	0.0000E+00	-4.0322E+07

RAD VERIFICATION - AMPLITUDES AT LOCAL ORIGIN

FREQ*	SURGE	SWAY	HEAVE	ROLL (deg)	PITCH (deg)	YAW (deg)
0.251	0.3493	0.7637	0.6765	0.0794	0.0340	0.0323
	0.3391	0.7574	0.6894	0.1198	0.0495	0.0457
	0.3381	0.7614	0.6945	0.1321	0.0543	0.0500
	0.3371	0.7668	0.7013	0.1464	0.0599	0.0550
	0.3359	0.7733	0.7103	0.1631	0.0665	0.0608
	0.3341	0.7817	0.7224	0.1826	0.0744	0.0675
	0.3315	0.7919	0.7388	0.2055	0.0838	0.0753
	0.3297	0.7971	0.7492	0.2184	0.0892	0.0796
	0.3275	0.8029	0.7612	0.2323	0.0951	0.0843
	0.3247	0.8090	0.7751	0.2473	0.1015	0.0893
	0.3212	0.8151	0.7913	0.2634	0.1087	0.0945
	0.3168	0.8212	0.8103	0.2807	0.1166	0.1001
	0.3113	0.8267	0.8322	0.2989	0.1253	0.1059
	0.3044	0.8313	0.8576	0.3181	0.1349	0.1119
	0.2956	0.8344	0.8870	0.3380	0.1455	0.1180
	0.2845	0.8343	0.9204	0.3577	0.1572	0.1240
	0.2702	0.8303	0.9587	0.3768	0.1701	0.1296
	0.2521	0.8197	1.0013	0.3934	0.1841	0.1344
	0.2288	0.8001	1.0480	0.4058	0.1992	0.1377
	0.1990	0.7679	1.0969	0.4103	0.2151	0.1388
	0.1610	0.7184	1.1431	0.4020	0.2308	0.1364
	0.1134	0.6459	1.1722	0.3715	0.2434	0.1289
	0.0595	0.5464	1.1420	0.2952	0.2444	0.1144
	0.0366	0.4871	0.9392	0.2733	0.2087	0.0911
	0.0495	0.2796	0.4955	0.3274	0.1151	0.0583
	0.0510	0.0749	0.1374	0.1715	0.0238	0.0188
	0.0539	0.0931	0.1144	0.0502	0.0176	0.0171
	0.0192	0.1220	0.0911	0.0124	0.0191	0.0256
	0.0267	0.0347	0.0186	0.0055	0.0008	0.0019
2.094	0.0079	0.0200	0.0024	0.0017	0.0006	0.0047

* same increments as on p. B-11

RAO VERIFICATION - PHASE ANGLES (deg)

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
0.251	-100.9	91.0	-11.4	80.3	85.0	3.6
	-107.2	91.4	-16.8	75.6	66.6	-6.3
	-109.1	91.6	-18.4	74.3	61.7	-8.6
	-111.5	91.7	-20.3	72.7	56.3	-11.4
	-114.3	91.6	-22.6	70.7	50.1	-14.1
	-117.7	91.7	-25.4	68.5	43.1	-17.2
	-121.8	91.7	-28.8	65.9	35.1	-20.8
	-124.2	91.5	-30.9	64.2	30.5	-22.9
	-126.9	91.3	-33.2	62.5	25.6	-25.0
	-129.9	91.3	-35.8	60.7	20.2	-27.1
	-133.3	90.9	-38.8	58.6	14.3	-29.6
	-137.2	90.3	-42.3	56.1	7.8	-32.5
	-141.5	89.9	-46.3	53.6	0.6	-35.3
	-146.6	89.1	-51.1	50.6	-7.5	-38.6
	-152.4	87.8	-56.7	47.0	-16.6	-42.6
	-159.1	86.5	-63.2	43.2	-26.8	-46.7
	-167.1	84.3	-71.2	38.3	-38.6	-52.0
	-176.6	81.7	-80.7	32.6	-52.2	-57.8
	171.9	77.7	-92.6	25.4	-68.3	-65.3
	157.4	72.6	-107.2	16.7	-87.4	-74.2
	138.7	65.4	-125.9	5.6	-110.9	-85.8
	112.1	55.7	-150.5	-8.4	-140.9	-100.6
	65.5	43.5	175.9	-24.9	179.2	-120.0
	-45.4	30.7	129.0	13.3	124.0	-145.8
	-118.0	-7.3	73.1	-64.7	53.0	179.3
	-140.2	-30.6	44.2	-109.2	-26.1	126.5
	-173.3	65.1	49.1	-153.3	73.0	-91.4
	128.7	4.3	-14.4	-115.6	-25.4	176.1
	-149.6	-7.6	-18.3	79.6	89.0	-39.7
2.094	-115.7	160.8	119.1	-104.9	108.1	-34.4

RAO VERIFICATION - COSINE COMPONENTS

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
0.251	-0.06594	-0.01310	0.66316	0.00023	0.00005	0.00056
	-0.10016	-0.01828	0.65999	0.00052	0.00034	0.00079
	-0.11052	-0.02103	0.65901	0.00062	0.00045	0.00086
	-0.12343	-0.02252	0.65776	0.00076	0.00058	0.00094
	-0.13811	-0.02136	0.65578	0.00094	0.00074	0.00103
	-0.15519	-0.02295	0.65260	0.00117	0.00095	0.00113
	-0.17457	-0.02325	0.64745	0.00146	0.00120	0.00123
	-0.18521	-0.02063	0.64290	0.00166	0.00134	0.00128
	-0.19653	-0.01797	0.63699	0.00187	0.00150	0.00133
	-0.20817	-0.01811	0.62871	0.00211	0.00166	0.00139
	-0.22018	-0.01256	0.61675	0.00240	0.00184	0.00143
	-0.23235	-0.00406	0.59940	0.00273	0.00202	0.00147
	-0.24354	0.00169	0.57504	0.00310	0.00219	0.00151
	-0.25405	0.01330	0.53865	0.00352	0.00233	0.00153
	-0.26189	0.03227	0.48712	0.00402	0.00243	0.00152
	-0.26573	0.05117	0.41516	0.00455	0.00245	0.00148
	-0.26335	0.08269	0.30917	0.00516	0.00232	0.00139
	-0.25165	0.11855	0.16208	0.00578	0.00197	0.00125
	-0.22650	0.17065	-0.04722	0.00640	0.00129	0.00100
	-0.18368	0.22981	-0.32399	0.00686	0.00017	0.00066
	-0.12090	0.29920	-0.66990	0.00698	-0.00144	0.00017
	-0.04263	0.36408	-1.01994	0.00641	-0.00329	-0.00041
	0.02469	0.39640	-1.13903	0.00467	-0.00426	-0.00100
	0.02570	0.41886	-0.59075	0.00464	-0.00204	-0.00131
	-0.02322	0.27733	0.14416	0.00244	0.00121	-0.00102
	-0.03917	0.06447	0.09852	-0.00098	0.00037	-0.00020
	-0.05353	0.03922	0.07492	-0.00078	0.00009	-0.00001
	-0.01200	0.12166	0.08824	-0.00009	0.00030	-0.00045
	-0.02302	0.03440	0.01766	0.00002	0.00000	0.00003
2.094	-0.00342	-0.01888	-0.00117	-0.00001	0.00000	0.00007

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RAO VERIFICATION - SIN COMPONENTS

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
0.251	-0.34302	0.76359	-0.13369	0.00137	0.00059	0.00004
	-0.32397	0.75718	-0.19922	0.00202	0.00079	-0.00009
	-0.31953	0.76111	-0.21918	0.00222	0.00083	-0.00013
	-0.31369	0.76647	-0.24326	0.00244	0.00087	-0.00019
	-0.30619	0.77300	-0.27292	0.00269	0.00089	-0.00026
	-0.29587	0.78136	-0.30981	0.00296	0.00089	-0.00035
	-0.28181	0.79156	-0.35586	0.00327	0.00084	-0.00047
	-0.27276	0.79683	-0.38468	0.00343	0.00079	-0.00054
	-0.26198	0.80270	-0.41674	0.00360	0.00072	-0.00062
	-0.24919	0.80880	-0.45333	0.00376	0.00061	-0.00071
	-0.23386	0.81500	-0.49575	0.00392	0.00047	-0.00081
	-0.21535	0.82119	-0.54526	0.00407	0.00028	-0.00094
	-0.19390	0.82670	-0.60157	0.00420	0.00002	-0.00107
	-0.16769	0.83119	-0.66733	0.00429	-0.00031	-0.00122
	-0.13708	0.83378	-0.74127	0.00431	-0.00073	-0.00139
	-0.10163	0.83273	-0.82145	0.00427	-0.00124	-0.00157
	-0.06047	0.82617	-0.90748	0.00407	-0.00185	-0.00178
	-0.01510	0.81108	-0.98810	0.00370	-0.00254	-0.00198
	0.03237	0.78169	-1.04694	0.00304	-0.00323	-0.00218
	0.07657	0.73271	-1.04796	0.00206	-0.00375	-0.00233
	0.10632	0.65313	-0.92624	0.00068	-0.00376	-0.00237
	0.10508	0.53351	-0.57772	-0.00095	-0.00268	-0.00221
	0.05414	0.37606	0.08231	-0.00217	0.00006	-0.00173
	-0.02606	0.24864	0.73015	0.00110	0.00302	-0.00089
	-0.04371	-0.03552	0.47407	-0.00516	0.00160	0.00001
	-0.03266	-0.03812	0.09578	-0.00283	-0.00018	0.00026
	-0.00632	0.08444	0.08646	-0.00039	0.00029	-0.00030
	0.01499	0.00915	-0.02265	-0.00020	-0.00014	0.00003
	-0.01352	-0.00459	-0.00584	0.00009	0.00001	-0.00002
2.094	-0.00712	0.00659	0.00210	-0.00003	0.00001	-0.00005

LOADS - COSINE COMPONENTS

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
0.251	4.1354E+00	-1.0191E+01	1.4160E+03	2.1152E+02	-3.4844E+05	-3.5907E+03
	9.8304E+00	-2.2407E+01	1.1219E+03	4.5663E+02	-2.5955E+05	-7.9386E+03
	1.2053E+01	-2.6823E+01	1.0240E+03	5.3694E+02	-2.2980E+05	-9.5571E+03
	1.4965E+01	-3.2616E+01	9.1220E+02	6.4760E+02	-1.9584E+05	-1.1643E+04
	1.8821E+01	-4.0749E+01	7.7847E+02	7.8457E+02	-1.5555E+05	-1.4505E+04
	2.3860E+01	-5.0291E+01	6.1431E+02	9.5391E+02	-1.0619E+05	-1.7972E+04
	3.0508E+01	-6.2342E+01	4.2619E+02	1.1566E+03	-5.0441E+04	-2.2351E+04
	3.4567E+01	-7.0136E+01	3.2153E+02	1.2921E+03	-1.9951E+04	-2.5092E+04
	3.9440E+01	-7.9012E+01	2.0475E+02	1.4269E+03	1.3649E+04	-2.8263E+04
	4.4806E+01	-8.8312E+01	8.9330E+01	1.5779E+03	4.6040E+04	-3.1723E+04
	5.1131E+01	-9.9517E+01	-4.0382E+01	1.7499E+03	8.1721E+04	-3.5699E+04
	5.8519E+01	-1.1389E+02	-1.7445E+02	1.9297E+03	1.1703E+05	-4.0672E+04
	6.6565E+01	-1.2814E+02	-3.0371E+02	2.1226E+03	1.4891E+05	-4.5856E+04
	7.5391E+01	-1.4479E+02	-4.2881E+02	2.3226E+03	1.7684E+05	-5.1691E+04
	8.4998E+01	-1.6504E+02	-5.4532E+02	2.5268E+03	1.9860E+05	-5.8452E+04
	9.4593E+01	-1.8364E+02	-6.3733E+02	2.7126E+03	2.0907E+05	-6.4851E+04
	1.0339E+02	-2.0745E+02	-6.9642E+02	2.8630E+03	2.0417E+05	-7.2287E+04
	1.0945E+02	-2.2978E+02	-6.9653E+02	2.9402E+03	1.7677E+05	-7.9002E+04
	1.0985E+02	-2.5183E+02	-6.3387E+02	2.8759E+03	1.2654E+05	-8.4229E+04
	9.9854E+01	-2.6693E+02	-4.8760E+02	2.6095E+03	5.3513E+04	-8.6034E+04
	7.4162E+01	-2.6487E+02	-2.8100E+02	2.0355E+03	-2.4061E+04	-7.9867E+04
	2.9800E+01	-2.3788E+02	-7.3911E+01	1.1190E+03	-6.6546E+04	-6.3251E+04
	-1.9819E+01	-1.5971E+02	1.6321E+01	9.3017E+01	-1.8698E+04	-2.9032E+04
	-2.3922E+01	-9.3397E+01	-3.0274E+01	3.4291E+02	7.3726E+04	2.0399E+03
	2.5338E+01	-3.9171E+01	9.8271E+01	-1.5131E+03	-1.3380E+04	1.8307E+04
	5.0851E+01	-1.0176E+01	8.4941E+01	-3.9703E+02	-3.4781E+04	6.2529E+03
	8.4195E+01	-5.6835E+01	-8.9147E+01	3.2837E+02	2.1732E+04	-1.7114E+04
	2.3279E+01	-1.0461E+01	-3.7919E+01	3.9756E+01	-1.8639E+04	1.6957E+04
	5.6555E+01	-1.0675E+02	-9.5093E+01	-1.3467E+01	2.3871E+04	-2.8506E+04
2.094	1.4928E+01	3.1344E+00	1.3078E+01	3.1572E+01	-3.2478E+03	-6.1480E+03

LOADS - SINE COMPONENTS

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
0.251	2.1512E+01	-6.3982E+01	-7.7847E+02	1.2552E+03	2.2160E+05	-1.6075E+04
	3.1797E+01	-9.6536E+01	-1.0317E+03	1.7561E+03	2.8972E+05	-2.3897E+04
	3.4848E+01	-1.0723E+02	-1.0874E+03	1.8958E+03	3.0363E+05	-2.6426E+04
	3.8034E+01	-1.1838E+02	-1.1466E+03	2.0424E+03	3.1800E+05	-2.8966E+04
	4.1726E+01	-1.3158E+02	-1.1984E+03	2.1971E+03	3.2892E+05	-3.1917E+04
	4.5489E+01	-1.4681E+02	-1.2420E+03	2.3439E+03	3.3605E+05	-3.5215E+04
	4.9249E+01	-1.6387E+02	-1.2638E+03	2.4897E+03	3.3474E+05	-3.8687E+04
	5.0706E+01	-1.7260E+02	-1.2673E+03	2.5530E+03	3.3086E+05	-4.0347E+04
	5.2575E+01	-1.8283E+02	-1.2587E+03	2.6051E+03	3.2277E+05	-4.2243E+04
	5.3636E+01	-1.9295E+02	-1.2355E+03	2.6354E+03	3.0954E+05	-4.4001E+04
	5.4308E+01	-2.0377E+02	-1.1992E+03	2.6446E+03	2.9152E+05	-4.5723E+04
	5.4237E+01	-2.1334E+02	-1.1438E+03	2.6231E+03	2.6693E+05	-4.6733E+04
	5.2998E+01	-2.2393E+02	-1.0613E+03	2.5583E+03	2.3364E+05	-4.7869E+04
	4.9763E+01	-2.3225E+02	-9.5869E+02	2.4427E+03	1.9392E+05	-4.8033E+04
	4.4490E+01	-2.3871E+02	-8.2239E+02	2.2455E+03	1.4432E+05	-4.7135E+04
	3.6178E+01	-2.4254E+02	-6.5612E+02	1.9737E+03	8.7499E+04	-4.5150E+04
	2.3740E+01	-2.3865E+02	-4.6218E+02	1.5772E+03	2.5632E+04	-4.0200E+04
	6.5674E+00	-2.2869E+02	-2.4598E+02	1.0703E+03	-3.6175E+04	-3.3191E+04
	-1.5699E+01	-2.0439E+02	-2.7915E+01	4.2204E+02	-8.7576E+04	-2.1344E+04
	-4.1626E+01	-1.6560E+02	1.5187E+02	-2.9112E+02	-1.1097E+05	-5.4177E+03
	-6.5218E+01	-1.0855E+02	2.4909E+02	-9.8784E+02	-8.9573E+04	1.5072E+04
	-7.3455E+01	-3.8673E+01	2.1988E+02	-1.4327E+03	-1.6604E+04	3.6824E+04
	-4.3460E+01	1.8742E+01	8.8874E+01	-1.2687E+03	6.1393E+04	4.9494E+04
	2.4257E+01	-5.6267E+01	5.6732E+01	-1.0580E+03	1.2053E+04	1.7792E+04
	4.7697E+01	3.3479E+01	9.0358E+01	-1.4954E+01	-6.7750E+04	1.7035E+04
	4.2400E+01	-4.3840E+01	-1.2727E+02	1.0432E+03	3.0923E+04	-1.7079E+04
	9.9404E+00	-3.1305E+01	-5.5221E+01	3.8357E+02	-2.6451E+03	3.0934E+03
	-2.9080E+01	-3.7103E+01	-4.7288E+01	1.9452E+02	2.0458E+04	-5.2885E+03
	3.3216E+01	3.2716E+00	3.6650E+01	-1.2941E+02	-1.0502E+04	1.4990E+03
2.094	3.1078E+01	2.5650E+01	4.5825E+00	1.0271E+02	-3.9332E+03	1.0128E+04

RAO RE-VERIFICATION - COSINE COMPONENTS

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
0.251	-6.5940E-02	-1.3100E-02	6.6316E-01	2.3000E-04	5.0000E-05	5.6000E-04
	-1.0016E-01	-1.8280E-02	6.5999E-01	5.2000E-04	3.4000E-04	7.9000E-04
	-1.1052E-01	-2.1030E-02	6.5901E-01	6.2000E-04	4.5000E-04	8.6000E-04
	-1.2343E-01	-2.2520E-02	6.5776E-01	7.6000E-04	5.8000E-04	9.4000E-04
	-1.3811E-01	-2.1360E-02	6.5578E-01	9.4000E-04	7.4000E-04	1.0300E-03
	-1.5519E-01	-2.2950E-02	6.5260E-01	1.1700E-03	9.5000E-04	1.1300E-03
	-1.7457E-01	-2.3250E-02	6.4745E-01	1.4600E-03	1.2000E-03	1.2300E-03
	-1.8521E-01	-2.0630E-02	6.4290E-01	1.6600E-03	1.3400E-03	1.2800E-03
	-1.9653E-01	-1.7970E-02	6.3699E-01	1.8700E-03	1.5000E-03	1.3300E-03
	-2.0817E-01	-1.8110E-02	6.2871E-01	2.1100E-03	1.6600E-03	1.3900E-03
	-2.2018E-01	-1.2560E-02	6.1675E-01	2.4000E-03	1.8400E-03	1.4300E-03
	-2.3235E-01	-4.0599E-03	5.9940E-01	2.7300E-03	2.0200E-03	1.4700E-03
	-2.4354E-01	1.6901E-03	5.7504E-01	3.1000E-03	2.1900E-03	1.5100E-03
	-2.5405E-01	1.3300E-02	5.3865E-01	3.5200E-03	2.3300E-03	1.5300E-03
	-2.6189E-01	3.2270E-02	4.8712E-01	4.0200E-03	2.4300E-03	1.5200E-03
	-2.6573E-01	5.1170E-02	4.1516E-01	4.5500E-03	2.4500E-03	1.4800E-03
	-2.6335E-01	8.2690E-02	3.0917E-01	5.1600E-03	2.3200E-03	1.3900E-03
	-2.5165E-01	1.1855E-01	1.6208E-01	5.7800E-03	1.9700E-03	1.2500E-03
	-2.2650E-01	1.7065E-01	-4.7220E-02	6.4000E-03	1.2900E-03	1.0000E-03
	-1.8368E-01	2.2981E-01	-3.2399E-01	6.8600E-03	1.7000E-04	6.6000E-04
	-1.2090E-01	2.9920E-01	-6.6990E-01	6.9800E-03	-1.4400E-03	1.7000E-04
	-4.2630E-02	3.6408E-01	-1.0199E+00	6.4100E-03	-3.2900E-03	-4.1000E-04
	2.4690E-02	3.9640E-01	-1.1390E+00	4.6700E-03	-4.2600E-03	-1.0000E-03
	2.5700E-02	4.1886E-01	-5.9075E-01	4.6400E-03	-2.0400E-03	-1.3100E-03
	-2.3220E-02	2.7733E-01	1.4416E-01	2.4400E-03	1.2100E-03	-1.0200E-03
	-3.9170E-02	6.4470E-02	9.8520E-02	-9.8000E-04	3.7000E-04	-2.0000E-04
	-5.3530E-02	3.9220E-02	7.4920E-02	-7.8000E-04	9.0000E-05	-1.0000E-05
	-1.2000E-02	1.2166E-01	8.8240E-02	-9.0000E-05	3.0000E-04	-4.5000E-04
	-2.3020E-02	3.4400E-02	1.7660E-02	2.0000E-05	2.9557E-11	3.0000E-05
2.094	-3.4200E-03	-1.8880E-02	-1.1700E-03	-1.0000E-05	1.5418E-12	7.0000E-05

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RAD RE-VERIFICATION - SINE COMPONENTS

FREQ	SURGE	SWAY	HEAVE	ROLL (RADS)	PITCH (RADS)	YAW (RADS)
0.251	-3.4302E-01	7.6359E-01	-1.3369E-01	1.3700E-03	5.9000E-04	4.0000E-05
	-3.2397E-01	7.5718E-01	-1.9922E-01	2.0200E-03	7.9000E-04	-9.0000E-05
	-3.1953E-01	7.6111E-01	-2.1918E-01	2.2200E-03	8.3000E-04	-1.3000E-04
	-3.1369E-01	7.6647E-01	-2.4326E-01	2.4400E-03	8.7000E-04	-1.9000E-04
	-3.0619E-01	7.7300E-01	-2.7292E-01	2.6900E-03	8.9000E-04	-2.6000E-04
	-2.9587E-01	7.8136E-01	-3.0981E-01	2.9600E-03	8.9000E-04	-3.5000E-04
	-2.8181E-01	7.9156E-01	-3.5586E-01	3.2700E-03	8.4000E-04	-4.7000E-04
	-2.7276E-01	7.9683E-01	-3.8468E-01	3.4300E-03	7.9000E-04	-5.4000E-04
	-2.6198E-01	8.0270E-01	-4.1674E-01	3.6000E-03	7.2000E-04	-6.2000E-04
	-2.4919E-01	8.0880E-01	-4.5333E-01	3.7600E-03	6.1000E-04	-7.1000E-04
	-2.3386E-01	8.1500E-01	-4.9575E-01	3.9200E-03	4.7000E-04	-8.1000E-04
	-2.1535E-01	8.2119E-01	-5.4526E-01	4.0700E-03	2.8000E-04	-9.4000E-04
	-1.9390E-01	8.2670E-01	-6.0157E-01	4.2000E-03	2.0001E-05	-1.0700E-03
	-1.6769E-01	8.3119E-01	-6.6733E-01	4.2900E-03	-3.1000E-04	-1.2200E-03
	-1.3708E-01	8.3378E-01	-7.4127E-01	4.3100E-03	-7.3000E-04	-1.3900E-03
	-1.0163E-01	8.3273E-01	-8.2145E-01	4.2700E-03	-1.2400E-03	-1.5700E-03
	-6.0470E-02	8.2617E-01	-9.0748E-01	4.0700E-03	-1.8500E-03	-1.7800E-03
	-1.5100E-02	8.1108E-01	-9.8810E-01	3.7000E-03	-2.5400E-03	-1.9800E-03
	3.2370E-02	7.8169E-01	-1.0469E+00	3.0400E-03	-3.2300E-03	-2.1800E-03
	7.6570E-02	7.3271E-01	-1.0480E+00	2.0600E-03	-3.7500E-03	-2.3300E-03
	1.0632E-01	6.5313E-01	-9.2624E-01	6.8000E-04	-3.7600E-03	-2.3700E-03
	1.0508E-01	5.3351E-01	-5.7772E-01	-9.5000E-04	-2.6800E-03	-2.2100E-03
	5.4140E-02	3.7606E-01	8.2310E-02	-2.1700E-03	6.0001E-05	-1.7300E-03
	-2.6060E-02	2.4864E-01	7.3015E-01	1.1000E-03	3.0200E-03	-8.9000E-04
	-4.3710E-02	-3.5520E-02	4.7407E-01	-5.1600E-03	1.6000E-03	1.0000E-05
	-3.2660E-02	-3.8120E-02	9.5780E-02	-2.8300E-03	-1.8000E-04	2.6000E-04
	-6.3200E-03	8.4440E-02	8.6460E-02	-3.9000E-04	2.9000E-04	-3.0000E-04
	1.4990E-02	9.1500E-03	-2.2650E-02	-2.0000E-04	-1.4000E-04	3.0000E-05
	-1.3520E-02	-4.5900E-03	-5.8400E-03	9.0000E-05	1.0000E-05	-2.0000E-05
2.094	-7.1200E-03	6.5900E-03	2.1000E-03	-3.0000E-05	1.0000E-05	-5.0000E-05

CASE 1

CONSTRAINED RAO - COSINE COMPONENTS

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
0.251	8.9136E-06	-1.0299E-04	6.6316E-01	2.3000E-04	5.0000E-05	-4.9007E-06
	2.1191E-05	-2.2780E-04	6.5999E-01	5.2000E-04	3.4000E-04	-1.0896E-05
	2.5983E-05	-2.7322E-04	6.5901E-01	6.2000E-04	4.5000E-04	-1.3140E-05
	3.2261E-05	-3.3293E-04	6.5776E-01	7.6000E-04	5.8000E-04	-1.6039E-05
	4.0575E-05	-4.1701E-04	6.5578E-01	9.4000E-04	7.4000E-04	-2.0030E-05
	5.1439E-05	-5.1622E-04	6.5260E-01	1.1700E-03	9.5000E-04	-2.4885E-05
	6.5775E-05	-6.4226E-04	6.4745E-01	1.4600E-03	1.2000E-03	-3.1052E-05
	7.4527E-05	-7.2401E-04	6.4290E-01	1.6600E-03	1.3400E-03	-3.4928E-05
	8.5037E-05	-8.1758E-04	6.3699E-01	1.8700E-03	1.5000E-03	-3.9430E-05
	9.6610E-05	-9.1616E-04	6.2871E-01	2.1100E-03	1.6600E-03	-4.4357E-05
	1.1025E-04	-1.0354E-03	6.1675E-01	2.4000E-03	1.8400E-03	-5.0051E-05
	1.2617E-04	-1.1889E-03	5.9940E-01	2.7300E-03	2.0200E-03	-5.7210E-05
	1.4354E-04	-1.3424E-03	5.7504E-01	3.1000E-03	2.1900E-03	-6.4717E-05
	1.6259E-04	-1.5229E-03	5.3865E-01	3.5200E-03	2.3300E-03	-7.3228E-05
	1.8331E-04	-1.7439E-03	4.8712E-01	4.0200E-03	2.4300E-03	-8.3194E-05
	2.0403E-04	-1.9502E-03	4.1516E-01	4.5500E-03	2.4500E-03	-9.2760E-05
	2.2301E-04	-2.2161E-03	3.0917E-01	5.1600E-03	2.3200E-03	-1.0406E-04
	2.3611E-04	-2.4708E-03	1.6208E-01	5.7800E-03	1.9700E-03	-1.1455E-04
	2.3699E-04	-2.7285E-03	-4.7220E-02	6.4000E-03	1.2900E-03	-1.2329E-04
	2.1546E-04	-2.9167E-03	-3.2399E-01	6.8600E-03	1.7000E-04	-1.2740E-04
	1.6004E-04	-2.9208E-03	-6.6990E-01	6.9800E-03	-1.4400E-03	-1.2018E-04
	6.4322E-05	-2.6477E-03	-1.0199E+00	6.4100E-03	-3.2900E-03	-9.7584E-05
	-4.2788E-05	-1.7806E-03	-1.1390E+00	4.6700E-03	-4.2600E-03	-4.7498E-05
	-5.1660E-05	-9.5882E-04	-5.9075E-01	4.6400E-03	-2.0400E-03	1.6922E-06
	5.4736E-05	-3.3681E-04	1.4416E-01	2.4400E-03	1.2100E-03	2.7271E-05
	1.0990E-04	-3.2389E-05	9.8520E-02	-9.8000E-04	3.7000E-04	1.1647E-05
	1.8207E-04	-7.0234E-04	7.4920E-02	-7.8000E-04	9.0000E-05	-2.9115E-05
	5.0381E-05	5.5915E-05	8.8240E-02	-9.0000E-05	3.0000E-04	3.0198E-05
	1.2254E-04	-1.4335E-03	1.7660E-02	2.0000E-05	2.9557E-11	-5.4734E-05
2.094	3.2477E-05	-2.1507E-04	-1.1700E-03	-1.0000E-05	1.5418E-12	-1.9418E-05

CONSTRAINED RAO - SINE COMPONENTS

CASE 1

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
0.251	4.6369E-05	-6.4489E-04	-1.3369E-01	1.3700E-03	5.9000E-04	-2.1950E-05
	6.8542E-05	-9.7744E-04	-1.9922E-01	2.0200E-03	7.9000E-04	-3.2833E-05
	7.5122E-05	-1.0873E-03	-2.1918E-01	2.2200E-03	8.3000E-04	-3.6382E-05
	8.1990E-05	-1.2022E-03	-2.4326E-01	2.4400E-03	8.7000E-04	-3.9968E-05
	8.9754E-05	-1.3389E-03	-2.7292E-01	2.6900E-03	8.9000E-04	-4.4162E-05
	9.8068E-05	-1.4972E-03	-3.0981E-01	2.9600E-03	8.9000E-04	-4.8890E-05
	1.0618E-04	-1.6757E-03	-3.5586E-01	3.2700E-03	8.4000E-04	-5.3935E-05
	1.0976E-04	-1.7676E-03	-3.8468E-01	3.4300E-03	7.9000E-04	-5.6381E-05
	1.1336E-04	-1.8757E-03	-4.1674E-01	3.6000E-03	7.2000E-04	-5.9202E-05
	1.1565E-04	-1.9833E-03	-4.5333E-01	3.7600E-03	6.1000E-04	-6.1864E-05
	1.1710E-04	-2.0990E-03	-4.9575E-01	3.9200E-03	4.7000E-04	-6.4526E-05
	1.1695E-04	-2.2026E-03	-5.4526E-01	4.0700E-03	2.8000E-04	-6.6244E-05
	1.1429E-04	-2.3182E-03	-6.0157E-01	4.2000E-03	2.0001E-05	-6.8212E-05
	1.0732E-04	-2.4110E-03	-6.6733E-01	4.2900E-03	-3.1000E-04	-6.8864E-05
	9.5951E-05	-2.4856E-03	-7.4127E-01	4.3100E-03	-7.3000E-04	-6.8095E-05
	7.8029E-05	-2.5340E-03	-8.2145E-01	4.2700E-03	-1.2400E-03	-6.5869E-05
	5.1206E-05	-2.5014E-03	-9.0748E-01	4.0700E-03	-1.8500E-03	-5.9455E-05
	1.4167E-05	-2.4046E-03	-9.8810E-01	3.7000E-03	-2.5400E-03	-5.0109E-05
	-3.3869E-05	-2.1519E-03	-1.0469E+00	3.0400E-03	-3.2300E-03	-3.3653E-05
	-8.9816E-05	-1.7380E-03	-1.0480E+00	2.0600E-03	-3.7500E-03	-1.0957E-05
	-1.4074E-04	-1.1134E-03	-9.2624E-01	6.8000E-04	-3.7600E-03	1.9169E-05
	-1.5855E-04	-3.3017E-04	-5.7772E-01	-9.5000E-04	-2.6800E-03	5.2375E-05
	-9.3826E-05	3.3918E-04	8.2310E-02	-2.1700E-03	6.0001E-05	7.3802E-05
	5.2384E-05	-4.9419E-04	7.3015E-01	1.1000E-03	3.0200E-03	2.7280E-05
	1.0304E-04	4.5089E-04	4.7407E-01	-5.1600E-03	1.6000E-03	2.8317E-05
	9.1635E-05	-5.3162E-04	9.5780E-02	-2.8300E-03	-1.8000E-04	-2.7219E-05
	2.1496E-05	-3.4041E-04	8.6460E-02	-3.9000E-04	2.9000E-04	2.9724E-06
	-6.2935E-05	-3.8025E-04	-2.2650E-02	-2.0000E-04	-1.4000E-04	-7.4077E-06
	7.1967E-05	-5.2702E-05	-5.8400E-03	9.0000E-05	1.0000E-05	-1.9008E-06
2.094	6.7614E-05	5.2729E-04	2.1000E-03	-3.0000E-05	1.0000E-05	2.5673E-05

CASE 1

CONSTRAINT FORCES Kips $ Kip-FT.

FREQ	SURGE-C	SURGE-S	SWAY-C	SWAY-S	YAW-C	YAW-S
0.251	4.1359E+00	2.1515E+01	-1.0299E+01	-6.4489E+01	-3.6265E+03	-1.6243E+04
	9.8324E+00	3.1803E+01	-2.2780E+01	-9.7744E+01	-8.0629E+03	-2.4297E+04
	1.2056E+01	3.4857E+01	-2.7322E+01	-1.0873E+02	-9.7233E+03	-2.6922E+04
	1.4969E+01	3.8044E+01	-3.3293E+01	-1.2022E+02	-1.1869E+04	-2.9576E+04
	1.8827E+01	4.1739E+01	-4.1701E+01	-1.3389E+02	-1.4822E+04	-3.2680E+04
	2.3868E+01	4.5504E+01	-5.1622E+01	-1.4972E+02	-1.8415E+04	-3.6179E+04
	3.0519E+01	4.9268E+01	-6.4226E+01	-1.6757E+02	-2.2979E+04	-3.9912E+04
	3.4580E+01	5.0927E+01	-7.2401E+01	-1.7676E+02	-2.5847E+04	-4.1722E+04
	3.9457E+01	5.2597E+01	-8.1758E+01	-1.8757E+02	-2.9178E+04	-4.3810E+04
	4.4327E+01	5.3660E+01	-9.1616E+01	-1.9833E+02	-3.2824E+04	-4.5779E+04
	5.1157E+01	5.4336E+01	-1.0354E+02	-2.0990E+02	-3.7038E+04	-4.7749E+04
	5.6551E+01	5.4267E+01	-1.1889E+02	-2.2026E+02	-4.2336E+04	-4.9021E+04
	6.6605E+01	5.3029E+01	-1.3424E+02	-2.3182E+02	-4.7891E+04	-5.0477E+04
	7.5439E+01	4.9795E+01	-1.5229E+02	-2.4110E+02	-5.4189E+04	-5.0959E+04
	8.5057E+01	4.4521E+01	-1.7439E+02	-2.4856E+02	-6.1564E+04	-5.0390E+04
	9.4666E+01	3.6205E+01	-1.9502E+02	-2.5340E+02	-6.8642E+04	-4.8743E+04
	1.0348E+02	2.3760E+01	-2.2161E+02	-2.5014E+02	-7.7004E+04	-4.3997E+04
	1.0955E+02	6.5736E+00	-2.4708E+02	-2.4046E+02	-8.4766E+04	-3.7081E+04
	1.0996E+02	-1.5715E+01	-2.7285E+02	-2.1519E+02	-9.1235E+04	-2.4903E+04
	9.9971E+01	-4.1675E+01	-2.9167E+02	-1.7380E+02	-9.4279E+04	-8.1081E+03
	7.4260E+01	-6.5305E+01	-2.9208E+02	-1.1134E+02	-8.8936E+04	1.4185E+04
	2.9845E+01	-7.3566E+01	-2.6477E+02	-3.3017E+01	-7.2212E+04	3.8758E+04
	-1.9854E+01	-4.3535E+01	-1.7806E+02	3.3918E+01	-3.5149E+04	5.4614E+04
	-2.3770E+01	2.4306E+01	-9.5882E+01	-4.9419E+01	1.2522E+03	2.0187E+04
	2.5398E+01	4.7809E+01	-3.3681E+01	4.5089E+01	2.0180E+04	2.0954E+04
	5.0994E+01	4.2519E+01	-3.2389E+00	-5.3162E+01	8.6187E+03	-2.0142E+04
	8.4481E+01	9.9742E+00	-7.0234E+01	-3.4041E+01	-2.1545E+04	2.1996E+03
	2.3377E+01	-2.9202E+01	5.5915E+00	-3.8025E+01	2.2346E+04	-5.4817E+03
	5.6856E+01	3.3393E+01	-1.4335E+02	-5.2702E+00	-4.0503E+04	-1.4066E+03
2.094	1.5070E+01	3.1373E+01	-2.1507E+01	5.2729E+01	-1.4369E+04	1.8998E+04

CONSTRAINT STIFFNESSES

SURGE	4.6400E+05	K/F
SWAY	1.0000E+05	K/F
YAW	7.4000E+08	KF/F

CONSTRAINED RAO - COSINE COMPONENTS

CASE 2

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
0.251	1.7830E-05	-1.0400E-04	6.6316E-01	2.3000E-04	5.0000E-05	-9.8942E-06
	4.2390E-05	-2.3136E-04	6.5999E-01	5.2000E-04	3.4000E-04	-2.2118E-05
	5.1979E-05	-2.7799E-04	6.5901E-01	6.2000E-04	4.5000E-04	-2.6717E-05
	6.4540E-05	-3.3944E-04	6.5776E-01	7.6000E-04	5.8000E-04	-3.2675E-05
	8.1173E-05	-4.2619E-04	6.5578E-01	9.4000E-04	7.4000E-04	-4.0903E-05
	1.0291E-04	-5.2914E-04	6.5260E-01	1.1700E-03	9.5000E-04	-5.0956E-05
	1.3160E-04	-6.6070E-04	6.4745E-01	1.4600E-03	1.2000E-03	-6.3796E-05
	1.4911E-04	-7.4626E-04	6.4290E-01	1.6600E-03	1.3400E-03	-7.1897E-05
	1.7015E-04	-8.4468E-04	6.3699E-01	1.8700E-03	1.5000E-03	-8.1346E-05
	1.9331E-04	-9.4892E-04	6.2871E-01	2.1100E-03	1.6600E-03	-9.1719E-05
	2.2062E-04	-1.0754E-03	6.1675E-01	2.4000E-03	1.8400E-03	-1.0378E-04
	2.5251E-04	-1.2390E-03	5.9940E-01	2.7300E-03	2.0200E-03	-1.1902E-04
	2.8726E-04	-1.4042E-03	5.7504E-01	3.1000E-03	2.1900E-03	-1.3510E-04
	3.2338E-04	-1.5992E-03	5.3865E-01	3.5200E-03	2.3300E-03	-1.5346E-04
	3.6898E-04	-1.8398E-03	4.8712E-01	4.0200E-03	2.4300E-03	-1.7519E-04
	4.0836E-04	-2.0683E-03	4.1516E-01	4.5500E-03	2.4500E-03	-1.9634E-04
	4.4639E-04	-2.3647E-03	3.0917E-01	5.1600E-03	2.3200E-03	-2.2175E-04
	4.7285E-04	-2.6549E-03	1.6208E-01	5.7800E-03	1.9700E-03	-2.4597E-04
	4.7448E-04	-2.9560E-03	-4.7220E-02	6.4000E-03	1.2900E-03	-2.6744E-04
	4.3112E-04	-3.1899E-03	-3.2399E-01	6.8600E-03	1.7000E-04	-2.7986E-04
	3.2051E-04	-3.2295E-03	-6.6990E-01	6.9800E-03	-1.4400E-03	-2.6869E-04
	1.2834E-04	-2.9645E-03	-1.0199E+00	6.4100E-03	-3.2900E-03	-2.2429E-04
	-8.5725E-05	-2.0116E-03	-1.1390E+00	4.6700E-03	-4.2600E-03	-1.1631E-04
	-1.0353E-04	-9.9027E-04	-5.9075E-01	4.6400E-03	-2.0400E-03	4.2134E-07
	1.0973E-04	-2.7065E-04	1.4416E-01	2.4400E-03	1.2100E-03	6.0441E-05
	2.2042E-04	8.6037E-05	9.8520E-02	-9.8000E-04	3.7000E-04	3.4190E-05
	3.6538E-04	-8.9508E-04	7.4920E-02	-7.8000E-04	9.0000E-05	-7.5701E-05
	1.0119E-04	3.3977E-04	8.8240E-02	-9.0000E-05	3.0000E-04	8.6093E-05
	2.4638E-04	-2.1106E-03	1.7660E-02	2.0000E-05	2.9557E-11	-1.7043E-04
2.094	6.5578E-05	-2.5970E-03	-1.1700E-03	-1.0000E-05	1.5418E-12	-2.5204E-04

CONSTRAINED RAO - SINE COMPONENTS

CASE 2

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
0.251	9.2750E-05	-6.4952E-04	-1.3369E-01	1.3700E-03	5.9000E-04	-4.4326E-05
	1.3711E-04	-9.8859E-04	-1.9922E-01	2.0200E-03	7.9000E-04	-6.6691E-05
	1.5028E-04	-1.1012E-03	-2.1918E-01	2.2200E-03	8.3000E-04	-7.4041E-05
	1.6402E-04	-1.2194E-03	-2.4326E-01	2.4400E-03	8.7000E-04	-8.1514E-05
	1.7996E-04	-1.3604E-03	-2.7292E-01	2.6900E-03	8.9000E-04	-9.0305E-05
	1.9620E-04	-1.5246E-03	-3.0981E-01	2.9600E-03	8.9000E-04	-1.0030E-04
	2.1244E-04	-1.7107E-03	-3.5586E-01	3.2700E-03	8.4000E-04	-1.1109E-04
	2.1960E-04	-1.8071E-03	-3.8468E-01	3.4300E-03	7.9000E-04	-1.1640E-04
	2.2681E-04	-1.9209E-03	-4.1674E-01	3.6000E-03	7.2000E-04	-1.2256E-04
	2.3140E-04	-2.0348E-03	-4.5333E-01	3.7600E-03	6.1000E-04	-1.2847E-04
	2.3432E-04	-2.1581E-03	-4.9575E-01	3.9200E-03	4.7000E-04	-1.3449E-04
	2.3403E-04	-2.2697E-03	-5.4526E-01	4.0700E-03	2.8000E-04	-1.3867E-04
	2.2871E-04	-2.3953E-03	-6.0157E-01	4.2000E-03	2.0001E-05	-1.4353E-04
	2.1477E-04	-2.4983E-03	-6.6733E-01	4.2900E-03	-3.1000E-04	-1.4578E-04
	1.9204E-04	-2.5837E-03	-7.4127E-01	4.3100E-03	-7.3000E-04	-1.4524E-04
	1.5618E-04	-2.6438E-03	-8.2145E-01	4.2700E-03	-1.2400E-03	-1.4187E-04
	1.0250E-04	-2.6191E-03	-9.0748E-01	4.0700E-03	-1.8500E-03	-1.2979E-04
	2.8361E-05	-2.5276E-03	-9.8810E-01	3.7000E-03	-2.5400E-03	-1.1160E-04
	-6.7810E-05	-2.2672E-03	-1.0469E+00	3.0400E-03	-3.2300E-03	-7.8015E-05
	-1.7984E-04	-1.8285E-03	-1.0480E+00	2.0600E-03	-3.7500E-03	-3.0386E-05
	-2.8186E-04	-1.1471E-03	-9.2624E-01	6.8000E-04	-3.7600E-03	3.5054E-05
	-3.1758E-04	-2.6847E-04	-5.7772E-01	-9.5000E-04	-2.6800E-03	1.1019E-04
	-1.8798E-04	5.2057E-04	8.2310E-02	-2.1700E-03	6.0001E-05	1.6405E-04
	1.0498E-04	-3.9297E-04	7.3015E-01	1.1000E-03	3.0200E-03	6.3797E-05
	2.0656E-04	6.1750E-04	4.7407E-01	-5.1600E-03	1.6000E-03	7.1912E-05
	1.8379E-04	-6.4369E-04	9.5780E-02	-2.8300E-03	-1.8000E-04	-6.4551E-05
	4.3139E-05	-4.0448E-04	8.6460E-02	-3.9000E-04	2.9000E-04	-4.8916E-08
	-1.2640E-04	-3.2398E-04	-2.2650E-02	-2.0000E-04	-1.4000E-04	-9.4844E-06
	1.4470E-04	-4.2130E-04	-5.8400E-03	9.0000E-05	1.0000E-05	-3.7596E-05
2.094	1.3652E-04	-1.4200E-03	2.1000E-03	-3.0000E-05	1.0000E-05	-1.2434E-04

CONSTRAINT FORCES Kips $ Kip - FT.

CASE 2

FREQ	SURGE-C	SURGE-S	SWAY-C	SWAY-S	YAW-C	YAW-S
0.251	4.1365E+00	2.1518E+01	-1.0400E+01	-6.4952E+01	-3.6609E+03	-1.6401E+04
	9.8345E+00	3.1810E+01	-2.3136E+01	-9.8859E+01	-8.1837E+03	-2.4676E+04
	1.2059E+01	3.4865E+01	-2.7799E+01	-1.1012E+02	-9.8855E+03	-2.7395E+04
	1.4973E+01	3.8054E+01	-3.3944E+01	-1.2194E+02	-1.2090E+04	-3.0160E+04
	1.8832E+01	4.1751E+01	-4.2619E+01	-1.3604E+02	-1.5134E+04	-3.3413E+04
	2.3876E+01	4.5519E+01	-5.2914E+01	-1.5246E+02	-1.8854E+04	-3.7109E+04
	3.0531E+01	4.9286E+01	-6.6070E+01	-1.7107E+02	-2.3605E+04	-4.1104E+04
	3.4594E+01	5.0947E+01	-7.4626E+01	-1.8071E+02	-2.6602E+04	-4.3066E+04
	3.9474E+01	5.2620E+01	-8.4468E+01	-1.9209E+02	-3.0098E+04	-4.5349E+04
	4.4848E+01	5.3685E+01	-9.4892E+01	-2.0348E+02	-3.3936E+04	-4.7535E+04
	5.1183E+01	5.4363E+01	-1.0754E+02	-2.1581E+02	-3.8398E+04	-4.9762E+04
	5.8582E+01	5.4296E+01	-1.2390E+02	-2.2697E+02	-4.4037E+04	-5.1308E+04
	6.6644E+01	5.3060E+01	-1.4042E+02	-2.3953E+02	-4.9985E+04	-5.3107E+04
	7.5488E+01	4.9827E+01	-1.5992E+02	-2.4983E+02	-5.6779E+04	-5.3938E+04
	8.5117E+01	4.4552E+01	-1.8398E+02	-2.5837E+02	-6.4820E+04	-5.3741E+04
	9.4738E+01	3.6233E+01	-2.0683E+02	-2.6438E+02	-7.2647E+04	-5.2493E+04
	1.0356E+02	2.3780E+01	-2.3647E+02	-2.6191E+02	-8.2047E+04	-4.8023E+04
	1.0766E+02	6.5798E+00	-2.6549E+02	-2.5276E+02	-9.1009E+04	-4.1294E+04
	1.1008E+02	-1.5732E+01	-2.9560E+02	-2.2672E+02	-9.8953E+04	-2.8866E+04
	1.0009E+02	-4.1724E+01	-3.1899E+02	-1.8285E+02	-1.0355E+05	-1.1243E+04
	7.4359E+01	-6.5391E+01	-3.2295E+02	-1.1471E+02	-9.9416E+04	1.2970E+04
	2.9890E+01	-7.3677E+01	-2.9645E+02	-2.6847E+01	-8.2986E+04	4.0771E+04
	-1.9888E+01	-4.3611E+01	-2.0116E+02	5.2057E+01	-4.3034E+04	6.0700E+04
	-2.4019E+01	2.4355E+01	-9.9027E+01	-3.9297E+01	1.5589E+02	2.3605E+04
	2.5458E+01	4.7922E+01	-2.7065E+01	6.1750E+01	2.2363E+04	2.6608E+04
	5.1137E+01	4.2638E+01	8.6037E+00	-6.4369E+01	1.2650E+04	-2.3884E+04
	8.4769E+01	1.0008E+01	-8.9508E+01	-4.0448E+01	-2.8009E+04	-1.8099E+01
	2.3476E+01	-2.9325E+01	3.3977E+01	-3.2398E+01	3.1854E+04	-3.5092E+03
	5.7161E+01	3.3571E+01	-2.1106E+02	-4.2130E+01	-6.3058E+04	-1.3910E+04
2.094	1.5214E+01	3.1674E+01	-2.5970E+02	-1.4200E+02	-9.3255E+04	-4.6004E+04

CONSTRAINT STIFFNESSES

SURGE	2.3200E+05	K/F
SWAY	1.0000E+05	K/F
YAW	3.7000E+08	Ki/F

CONSTRAINED RAD - COSINE COMPONENTS

CASE 3

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
0.251	1.7830E-05	-2.0816E-04	6.6316E-01	2.3000E-04	5.0000E-05	-9.9000E-06
	4.[illegible]390E-05	-4.6331E-04	6.5999E-01	5.2000E-04	3.4000E-04	-2.2138E-05
	5.1979E-05	-5.5677E-04	6.5901E-01	6.2000E-04	4.5000E-04	-2.6744E-05
	6.4540E-05	-6.7994E-04	6.5776E-01	7.6000E-04	5.8000E-04	-3.2711E-05
	8.1173E-05	-8.5390E-04	6.5578E-01	9.4000E-04	7.4000E-04	-4.0955E-05
	1.0291E-04	-1.0604E-03	6.5260E-01	1.1700E-03	9.5000E-04	-5.1029E-05
	1.3160E-04	-1.3244E-03	6.4745E-01	1.4600E-03	1.2000E-03	-6.3899E-05
	1.4911E-04	-1.4961E-03	6.4290E-01	1.6600E-03	1.3400E-03	-7.2021E-05
	1.7015E-04	-1.6938E-03	6.3699E-01	1.8700E-03	1.5000E-03	-8.1497E-05
	1.9331E-04	-1.9031E-03	6.2871E-01	2.1100E-03	1.6600E-03	-9.1900E-05
	2.2062E-04	-2.1573E-03	6.1675E-01	2.4000E-03	1.8400E-03	-1.0400E-04
	2.5251E-04	-2.4861E-03	5.9940E-01	2.7300E-03	2.0200E-03	-1.1930E-04
	2.8726E-04	-2.8183E-03	5.7504E-01	3.1000E-03	2.1900E-03	-1.3544E-04
	3.2538E-04	-3.2107E-03	5.3865E-01	3.5200E-03	2.3300E-03	-1.5388E-04
	3.6688E-04	-3.6951E-03	4.8712E-01	4.0200E-03	2.4300E-03	-1.7572E-04
	4.0836E-04	-4.1555E-03	4.1516E-01	4.5500E-03	2.4500E-03	-1.9700E-04
	4.4639E-04	-4.7535E-03	3.0917E-01	5.1600E-03	2.3200E-03	-2.2258E-04
	4.7285E-04	-5.3397E-03	1.6208E-01	5.7800E-03	1.9700E-03	-2.4701E-04
	4.7448E-04	-5.9500E-03	-4.7220E-02	6.4000E-03	1.2900E-03	-2.6876E-04
	4.3142E-04	-6.4267E-03	-3.2399E-01	6.8600E-03	1.7000E-04	-2.8150E-04
	3.2051E-04	-6.5145E-03	-6.6990E-01	6.9800E-03	-1.4400E-03	-2.7065E-04
	1.2884E-04	-5.9908E-03	-1.0199E+00	6.4100E-03	-3.2900E-03	-2.2647E-04
	-8.5725E-05	-4.0760E-03	-1.1390E+00	4.6700E-03	-4.2600E-03	-1.1820E-04
	-1.0353E-04	-2.0040E-03	-5.9075E-01	4.6400E-03	-2.0400E-03	-4.1005E-07
	1.0973E-04	-5.5762E-04	1.4416E-01	2.4400E-03	1.2100E-03	5.9831E-05
	2.2042E-04	1.8535E-04	9.8520E-02	-9.8000E-04	3.7000E-04	3.4704E-05
	3.6539E-04	-1.8244E-03	7.4920E-02	-7.8000E-04	9.0000E-05	-7.6936E-05
	1.0119E-04	7.0954E-04	8.8240E-02	-9.0000E-05	3.0000E-04	8.7252E-05
	2.4638E-04	-4.3954E-03	1.7660E-02	2.0000E-05	2.9557E-11	-1.7708E-04
2.094	6.5578E-05	-4.0398E-03	-1.1700E-03	-1.0000E-05	1.5418E-12	-1.9829E-04

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CASE 3

CONSTRAINED RAO - SINE COMPONENTS

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
0.251	9.2750E-05	-1.3001E-03	-1.3369E-01	1.3700E-03	5.9000E-04	-4.4363E-05
	1.3711E-04	-1.9798E-03	-1.9922E-01	2.0200E-03	7.9000E-04	-6.6782E-05
	1.5028E-04	-2.2058E-03	-2.1918E-01	2.2200E-03	8.3000E-04	-7.4154E-05
	1.6402E-04	-2.4429E-03	-2.4326E-01	2.4400E-03	8.7000E-04	-8.1655E-05
	1.7996E-04	-2.7261E-03	-2.7292E-01	2.6900E-03	8.9000E-04	-9.0484E-05
	1.9620E-04	-3.0559E-03	-3.0981E-01	2.9600E-03	8.9000E-04	-1.0053E-04
	2.1244E-04	-3.4301E-03	-3.5586E-01	3.2700E-03	8.4000E-04	-1.1139E-04
	2.1960E-04	-3.6240E-03	-3.8468E-01	3.4300E-03	7.9000E-04	-1.1674E-04
	2.2681E-04	-3.8532E-03	-4.1674E-01	3.6000E-03	7.2000E-04	-1.2296E-04
	2.3140E-04	-4.0828E-03	-4.5333E-01	3.7600E-03	6.1000E-04	-1.2893E-04
	2.3432E-04	-4.3314E-03	-4.9575E-01	3.9200E-03	4.7000E-04	-1.3502E-04
	2.3403E-04	-4.5571E-03	-5.4526E-01	4.0700E-03	2.8000E-04	-1.3928E-04
	2.2371E-04	-4.8112E-03	-6.0157E-01	4.2000E-03	2.0001E-05	-1.4425E-04
	2.1477E-04	-5.0205E-03	-6.6733E-01	4.2900E-03	-3.1000E-04	-1.4661E-04
	1.9204E-04	-5.1950E-03	-7.4127E-01	4.3100E-03	-7.3000E-04	-1.4621E-04
	1.5618E-04	-5.3194E-03	-8.2145E-01	4.2700E-03	-1.2400E-03	-1.4299E-04
	1.0250E-04	-5.2743E-03	-9.0748E-01	4.0700E-03	-1.8500E-03	-1.3106E-04
	2.8361E-05	-5.0956E-03	-9.8810E-01	3.7000E-03	-2.5400E-03	-1.1303E-04
	-6.7810E-05	-4.5775E-03	-1.0469E+00	3.0400E-03	-3.2300E-03	-7.9547E-05
	-1.7984E-04	-3.7003E-03	-1.0480E+00	2.0600E-03	-3.7500E-03	-3.1935E-05
	-2.8186E-04	-2.3320E-03	-9.2624E-01	6.8000E-04	-3.7600E-03	3.3686E-05
	-3.1758E-04	-5.6144E-04	-5.7772E-01	-9.5000E-04	-2.6800E-03	1.0928E-04
	-1.8798E-04	1.0377E-03	8.2310E-02	-2.1700E-03	6.0001E-05	1.6389E-04
	1.0498E-04	-8.0667E-04	7.3015E-01	1.1000E-03	3.0200E-03	6.3029E-05
	2.0656E-04	1.2514E-03	4.7407E-01	-5.1600E-03	1.6000E-03	7.2496E-05
	1.8379E-04	-1.3106E-03	9.5780E-02	-2.8300E-03	-1.8000E-04	-6.5391E-05
	4.3139E-05	-8.4596E-04	8.6460E-02	-3.9000E-04	2.9000E-04	-1.4742E-06
	-1.2640E-04	-6.5883E-04	-2.2650E-02	-2.0000E-04	-1.4000E-04	-9.8583E-06
	1.4470E-04	-9.7317E-04	-5.8400E-03	9.0000E-05	1.0000E-05	-4.2991E-05
2.094	1.3652E-04	-4.0116E-03	2.1000E-03	-3.0000E-05	1.0000E-05	-1.7452E-04

CONSTRAINT FORCES kips & kip - FT.

CASE 3

FREQ	SURGE-C	SURGE-S	SWAY-C	SWAY-S	YAW-C	YAW-S
0.251	4.1365E+00	2.1518E+01	-1.0408E+01	-6.5007E+01	-3.6630E+03	-1.6414E+04
	9.8345E+00	3.1810E+01	-2.3165E+01	-9.8992E+01	-8.1912E+03	-2.4709E+04
	1.2059E+01	3.4865E+01	-2.7839E+01	-1.1029E+02	-9.8954E+03	-2.7437E+04
	1.4973E+01	3.8054E+01	-3.3997E+01	-1.2215E+02	-1.2103E+04	-3.0212E+04
	1.8832E+01	4.1751E+01	-4.2695E+01	-1.3631E+02	-1.5153E+04	-3.3479E+04
	2.3876E+01	4.5519E+01	-5.3020E+01	-1.5280E+02	-1.8881E+04	-3.7195E+04
	3.0531E+01	4.9286E+01	-6.6219E+01	-1.7151E+02	-2.3642E+04	-4.1214E+04
	3.4594E+01	5.0947E+01	-7.4807E+01	-1.8120E+02	-2.6648E+04	-4.3192E+04
	3.9474E+01	5.2620E+01	-8.4688E+01	-1.9266E+02	-3.0154E+04	-4.5494E+04
	4.4848E+01	5.3685E+01	-9.5157E+01	-2.0414E+02	-3.4003E+04	-4.7703E+04
	5.1183E+01	5.4363E+01	-1.0787E+02	-2.1657E+02	-3.8480E+04	-4.9957E+04
	5.8582E+01	5.4296E+01	-1.2431E+02	-2.2785E+02	-4.4140E+04	-5.1534E+04
	6.6644E+01	5.3060E+01	-1.4091E+02	-2.4056E+02	-5.0112E+04	-5.3371E+04
	7.5488E+01	4.9827E+01	-1.6053E+02	-2.5102E+02	-5.6935E+04	-5.4244E+04
	8.5117E+01	4.4552E+01	-1.8476E+02	-2.5975E+02	-6.5018E+04	-5.4096E+04
	9.4738E+01	3.6233E+01	-2.0778E+02	-2.6597E+02	-7.2890E+04	-5.2905E+04
	1.0356E+02	2.3780E+01	-2.3768E+02	-2.6371E+02	-8.2356E+04	-4.8492E+04
	1.0966E+02	6.5798E+00	-2.6699E+02	-2.5478E+02	-9.1395E+04	-4.1821E+04
	1.1008E+02	-1.5732E+01	-2.9750E+02	-2.2888E+02	-9.9443E+04	-2.9433E+04
	1.0009E+02	-4.1724E+01	-3.2134E+02	-1.8502E+02	-1.0416E+05	-1.1816E+04
	7.4359E+01	-6.5391E+01	-3.2573E+02	-1.1660E+02	-1.0014E+05	1.2464E+04
	2.9890E+01	-7.3677E+01	-2.9954E+02	-2.8072E+01	-8.3795E+04	4.0434E+04
	-1.9888E+01	-4.3611E+01	-2.0380E+02	5.1884E+01	-4.3735E+04	6.0640E+04
	-2.4019E+01	2.4355E+01	-1.0020E+02	-4.0334E+01	-1.5172E+02	2.3321E+04
	2.5458E+01	4.7922E+01	-2.7881E+01	6.2571E+01	2.2137E+04	2.6823E+04
	5.1137E+01	4.2638E+01	9.2673E+00	-6.5528E+01	1.2840E+04	-2.4195E+04
	8.4769E+01	1.0008E+01	-9.1219E+01	-4.2298E+01	-2.8466E+04	-5.4547E+02
	2.3476E+01	-2.9325E+01	3.5477E+01	-3.2941E+01	3.2283E+04	-3.6476E+03
	5.7161E+01	3.3571E+01	-2.1977E+02	-4.8658E+01	-6.5518E+04	-1.5907E+04
2.094	1.5214E+01	3.1674E+01	-2.0199E+02	-2.0058E+02	-7.3369E+04	-6.4572E+04

CONSTRAINT STIFFNESSES

SURGE	2.3200E+05	K/F
SWAY	5.0000E+04	K/F
YAW	3.7000E+08	KF/F

CASE 4

CONSTRAINED RAO - COSINE COMPONENTS

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
.251	4.1354E-12	-1.0191E-11	6.6316E-01	2.3000E-04	5.0000E-05	-3.5907E-12
	9.8304E-12	-2.2407E-11	6.5999E-01	5.2000E-04	3.4000E-04	-7.9386E-12
	1.2053E-11	-2.6823E-11	6.5901E-01	6.2000E-04	4.5000E-04	-9.5571E-12
	1.4965E-11	-3.2616E-11	6.5776E-01	7.6000E-04	5.8000E-04	-1.1643E-11
	1.8321E-11	-4.0749E-11	6.5578E-01	9.4000E-04	7.4000E-04	-1.4505E-11
	2.3860E-11	-5.0291E-11	6.5260E-01	1.1700E-03	9.5000E-04	-1.7972E-11
	3.0508E-11	-6.2342E-11	6.4745E-01	1.4600E-03	1.2000E-03	-2.2351E-11
	3.4567E-11	-7.0136E-11	6.4290E-01	1.6600E-03	1.3400E-03	-2.5092E-11
	3.9440E-11	-7.9012E-11	6.3699E-01	1.8700E-03	1.5000E-03	-2.8263E-11
	4.4806E-11	-8.8312E-11	6.2871E-01	2.1100E-03	1.6600E-03	-3.1723E-11
	5.1131E-11	-9.9517E-11	6.1675E-01	2.4000E-03	1.8400E-03	-3.5699E-11
	5.8519E-11	-1.1389E-10	5.9940E-01	2.7300E-03	2.0200E-03	-4.0672E-11
	6.6565E-11	-1.2814E-10	5.7504E-01	3.1000E-03	2.1900E-03	-4.5856E-11
	7.5391E-11	-1.4479E-10	5.3865E-01	3.5200E-03	2.3300E-03	-5.1691E-11
	8.4998E-11	-1.6504E-10	4.8712E-01	4.0200E-03	2.4300E-03	-5.8452E-11
	9.4597E-11	-1.8364E-10	4.1516E-01	4.5500E-03	2.4500E-03	-6.4851E-11
	1.0339E-10	-2.0745E-10	3.0917E-01	5.1600E-03	2.3200E-03	-7.2287E-11
	1.0745E-10	-2.2978E-10	1.6208E-01	5.7800E-03	1.9700E-03	-7.9002E-11
	1.0985E-10	-2.5183E-10	-4.7220E-02	6.4000E-03	1.2900E-03	-8.4229E-11
	9.9854E-11	-2.6693E-10	-3.2399E-01	6.8600E-03	1.7000E-04	-8.6034E-11
	7.4162E-11	-2.6487E-10	-6.6990E-01	6.9800E-03	-1.4400E-03	-7.9867E-11
	2.9900E-11	-2.3788E-10	-1.0199E+00	6.4100E-03	-3.2900E-03	-6.3251E-11
	-1.9819E-11	-1.5971E-10	-1.1390E+00	4.6700E-03	-4.2600E-03	-2.9032E-11
	-2.3922E-11	-9.3397E-11	-5.9075E-01	4.6400E-03	-2.0400E-03	2.0399E-12
	2.5338E-11	-3.9171E-11	1.4416E-01	2.4400E-03	1.2100E-03	1.8307E-11
	5.0851E-11	-1.0176E-11	9.8520E-02	-9.8000E-04	3.7000E-04	6.2529E-12
	8.4195E-11	-5.6835E-11	7.4920E-02	-7.8000E-04	9.0000E-05	-1.7114E-11
	2.3279E-11	-1.0461E-11	8.8240E-02	-9.0000E-05	3.0000E-04	1.6957E-11
	5.6555E-11	-1.0675E-10	1.7660E-02	2.0000E-05	2.9557E-11	-2.8506E-11
2.094	1.4928E-11	3.1344E-12	-1.1700E-03	-1.0000E-05	1.5418E-12	-6.1480E-12

CONSTRAINED RAO - SINE COMPONENTS

CASE 4

FREQ	SURGE	SWAY	HEAVE	ROLL	PITCH	YAW
0.251	2.1512E-11	-6.3982E-11	-1.3369E-01	1.3700E-03	5.9000E-04	-1.6075E-11
	3.1797E-11	-9.6536E-11	-1.9922E-01	2.0200E-03	7.9000E-04	-2.3897E-11
	3.4848E-11	-1.0723E-10	-2.1918E-01	2.2200E-03	8.3000E-04	-2.6426E-11
	3.8034E-11	-1.1838E-10	-2.4326E-01	2.4400E-03	8.7000E-04	-2.8966E-11
	4.1726E-11	-1.3158E-10	-2.7292E-01	2.6900E-03	8.9000E-04	-3.1917E-11
	4.5189E-11	-1.4681E-10	-3.0981E-01	2.9600E-03	8.9000E-04	-3.5215E-11
	4.9249E-11	-1.6387E-10	-3.5586E-01	3.2700E-03	8.4000E-04	-3.8687E-11
	5.0906E-11	-1.7260E-10	-3.8468E-01	3.4300E-03	7.9000E-04	-4.0347E-11
	5.2575E-11	-1.8283E-10	-4.1674E-01	3.6000E-03	7.2000E-04	-4.2243E-11
	5.3636E-11	-1.9295E-10	-4.5333E-01	3.7600E-03	6.1000E-04	-4.4001E-11
	5.4308E-11	-2.0377E-10	-4.9575E-01	3.9200E-03	4.7000E-04	-4.5723E-11
	5.4237E-11	-2.1334E-10	-5.4526E-01	4.0700E-03	2.8000E-04	-4.6733E-11
	5.2998E-11	-2.2393E-10	-6.0157E-01	4.2000E-03	2.0001E-05	-4.7869E-11
	4.9763E-11	-2.3225E-10	-6.6733E-01	4.2900E-03	-3.1000E-04	-4.8033E-11
	4.4490E-11	-2.3871E-10	-7.4127E-01	4.3100E-03	-7.3000E-04	-4.7135E-11
	3.6178E-11	-2.4254E-10	-8.2145E-01	4.2700E-03	-1.2400E-03	-4.5150E-11
	2.3740E-11	-2.3865E-10	-9.0748E-01	4.0700E-03	-1.8500E-03	-4.0200E-11
	6.5674E-12	-2.2869E-10	-9.8810E-01	3.7000E-03	-2.5400E-03	-3.3191E-11
	-1.5699E-11	-2.0439E-10	-1.0469E+00	3.0400E-03	-3.2300E-03	-2.1344E-11
	-4.1626E-11	-1.6560E-10	-1.0480E+00	2.0600E-03	-3.7500E-03	-5.4177E-12
	-6.5218E-11	-1.0855E-10	-9.2624E-01	6.8000E-04	-3.7600E-03	1.5072E-11
	-7.3155E-11	-3.8673E-11	-5.7772E-01	-9.5000E-04	-2.6800E-03	3.6824E-11
	-4.3460E-11	1.8742E-11	8.2310E-02	-2.1700E-03	6.0001E-05	4.9494E-11
	2.4257E-11	-5.6267E-11	7.3015E-01	1.1000E-03	3.0200E-03	1.7792E-11
	4.7597E-11	3.3479E-11	4.7407E-01	-5.1600E-03	1.6000E-03	1.7035E-11
	4.2400E-11	-4.3840E-11	9.5780E-02	-2.8300E-03	-1.8000E-04	-1.7079E-11
	9.9404E-12	-3.1305E-11	8.6460E-02	-3.9000E-04	2.9000E-04	3.0934E-12
	-2.9080E-11	-3.7103E-11	-2.2650E-02	-2.0000E-04	-1.4000E-04	-5.2885E-12
	3.3216E-11	3.2716E-12	-5.8400E-03	9.0000E-05	1.0000E-05	1.4990E-12
2.094	3.1078E-11	2.5650E-11	2.1000E-03	-3.0000E-05	1.0000E-05	1.0128E-11

CASE 4

CONSTRAINT FORCES

FREQ	SURGE-C	SURGE-S	SWAY-C	SWAY-S	YAW-C	YAW-S
0.251	4.1354E+00	2.1512E+01	-1.0191E+01	-6.3982E+01	-3.5907E+03	-1.6075E+04
	9.8304E+00	3.1797E+01	-2.2407E+01	-9.6536E+01	-7.9386E+03	-2.3897E+04
	1.2053E+01	3.4848E+01	-2.6823E+01	-1.0723E+02	-9.5571E+03	-2.6426E+04
	1.4965E+01	3.8034E+01	-3.2616E+01	-1.1838E+02	-1.1643E+04	-2.8966E+04
	1.8821E+01	4.1726E+01	-4.0749E+01	-1.3158E+02	-1.4505E+04	-3.1917E+04
	2.3860E+01	4.5489E+01	-5.0291E+01	-1.4681E+02	-1.7972E+04	-3.5215E+04
	3.0508E+01	4.9249E+01	-6.2342E+01	-1.6387E+02	-2.2351E+04	-3.8687E+04
	3.4567E+01	5.0906E+01	-7.0134E+01	-1.7260E+02	-2.5092E+04	-4.0347E+04
	3.9440E+01	5.2575E+01	-7.9012E+01	-1.8283E+02	-2.8263E+04	-4.2243E+04
	4.4806E+01	5.3636E+01	-8.8312E+01	-1.9295E+02	-3.1723E+04	-4.4001E+04
	5.1131E+01	5.4308E+01	-9.9517E+01	-2.0377E+02	-3.5699E+04	-4.5723E+04
	5.8519E+01	5.4237E+01	-1.1389E+02	-2.1334E+02	-4.0672E+04	-4.6733E+04
	6.6565E+01	5.2998E+01	-1.2814E+02	-2.2393E+02	-4.5856E+04	-4.7869E+04
	7.5391E+01	4.9763E+01	-1.4479E+02	-2.3225E+02	-5.1691E+04	-4.8033E+04
	8.4998E+01	4.4490E+01	-1.6504E+02	-2.3871E+02	-5.8452E+04	-4.7135E+04
	9.4593E+01	3.6178E+01	-1.8364E+02	-2.4254E+02	-6.4851E+04	-4.5150E+04
	1.0339E+02	2.3740E+01	-2.0745E+02	-2.3865E+02	-7.2287E+04	-4.0200E+04
	1.0945E+02	6.5674E+00	-2.2978E+02	-2.2869E+02	-7.9002E+04	-3.3191E+04
	1.0985E+02	-1.5699E+01	-2.5183E+02	-2.0439E+02	-8.4229E+04	-2.1344E+04
	9.9854E+01	-4.1626E+01	-2.6693E+02	-1.6560E+02	-8.6034E+04	-5.4177E+03
	7.4162E+01	-6.5218E+01	-2.6487E+02	-1.0855E+02	-7.9867E+04	1.5072E+04
	2.9800E+01	-7.3455E+01	-2.3788E+02	-3.8673E+01	-6.3251E+04	3.6824E+04
	-1.9819E+01	-4.3460E+01	-1.5971E+02	1.8742E+01	-2.9032E+04	4.9494E+04
	-2.3922E+01	2.4257E+01	-9.3397E+01	-5.6267E+01	2.0399E+03	1.7792E+04
	2.5338E+01	4.7697E+01	-3.9171E+01	3.3479E+01	1.8307E+04	1.7035E+04
	5.0851E+01	4.2400E+01	-1.0176E+01	-4.3840E+01	6.2529E+03	-1.7079E+04
	8.4195E+01	9.9404E+00	-5.6835E+01	-3.1305E+01	-1.7114E+04	3.0934E+03
	2.3279E+01	-2.9080E+01	-1.0461E+01	-3.7103E+01	1.6957E+04	-5.2885E+03
	5.6555E+01	3.3216E+01	-1.0675E+02	3.2716E+00	-2.8506E+04	1.4990E+03
2.094	1.4928E+01	3.1078E+01	3.1344E+00	2.5650E+01	-6.1480E+03	1.0128E+04

CONSTRAINT STIFFNESSES

SURGE	1.0000E+12	K/F
SWAY	1.0000E+12	K/F
YAW	1.0000E+15	KF/F

SIGNIFICANT HEIGHT =	6.00	FT.
MEAN ZERO-CROSSING PERIOD =	5.50	SEC

Values are:

Average of (1/3 x Spectral peaks) x 1.92.

MAXIMA

Motions:

SURGE	4.3859E-10	FT.
SWAY	1.1377E-09	FT.
HEAVE	4.9076E+00	FT.
ROLL	3.0153E-02	RAD
PITCH	1.7564E-02	RAD
YAW	3.2339E-10	RAD

SURGE FORCE =	4.3859E+02	K
SWAY FORCE =	1.1377E+03	K
YAW MOMENT =	3.2339E+05	KF

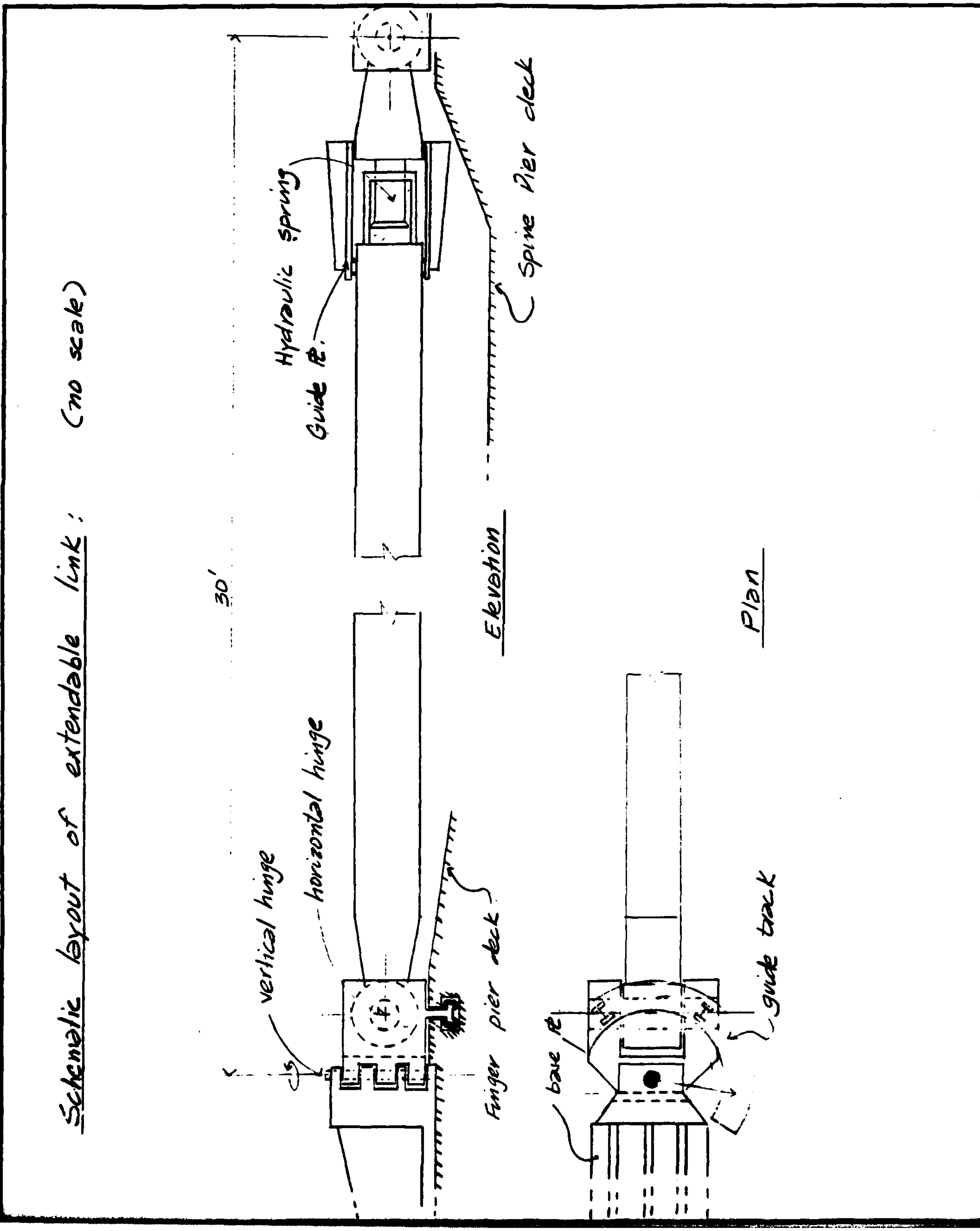
APPENDIX C

EXTENDABLE LINK DESIGN

TYLIN INTERNATIONAL
STRUCTURAL ENGINEERING
315 Bay St., San Francisco, Ca. 94133

PROJECT:	ONR Navy Pier Concepts.
ITEM:	Finger / Spine Conn.
DESIGN:	Link Schematic
DATE:	

SHEET: C-1
OF
REVISION:



TYLIN INTERNATIONAL
STRUCTURAL ENGINEERING
315 Bay St., San Francisco, Ca. 94133

PROJECT: ONR Navy Pier Concepts	SHEET: C-2.
ITEM: Finger / spine conn.	OF
DESIGN: LINKS	REVISION:
DATE:	

Consider max. tension $\simeq$ 10,000 kips / link.

For Fatigue loading over 2 million cycles and Type B details, non-redundant load path.

Allowable American Welding Society (AWS) stress range

F_{sr} = 16 KSI.

Assume 50% compression load since compression will be taken by bearing against spine pier.

$\therefore$ Allow tensile stress of 12 KSI

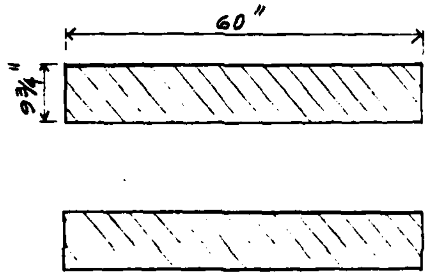
Since allow. fatigue stress controls; use A36 steel.

$F_t = 0.45 F_y = 16.2^{KSI} > 12^{KSI}$ (static load requirement).

$$A_n \text{ req.} = \frac{10{,}000^{K}}{12^{KSI}} = 833 \text{ in}^2$$

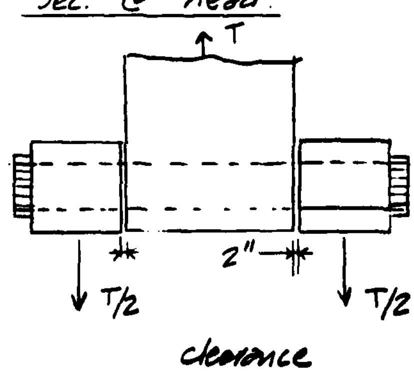
At pin connection (head) $1.5\,A_{nreq} > A_n > 1.33\,A_{nreq}$ (AISC 1.14.5)

Let $A_n = 1.4\,A_{nreq} = 1.4 \times 833 = 1166 \text{ in}^2$



$\underline{A_n = 1170 \text{ in}^2}$

Sec. @ head



<u>Pin design</u> (use 100 KSI steel)

Use AASHTO design parameters

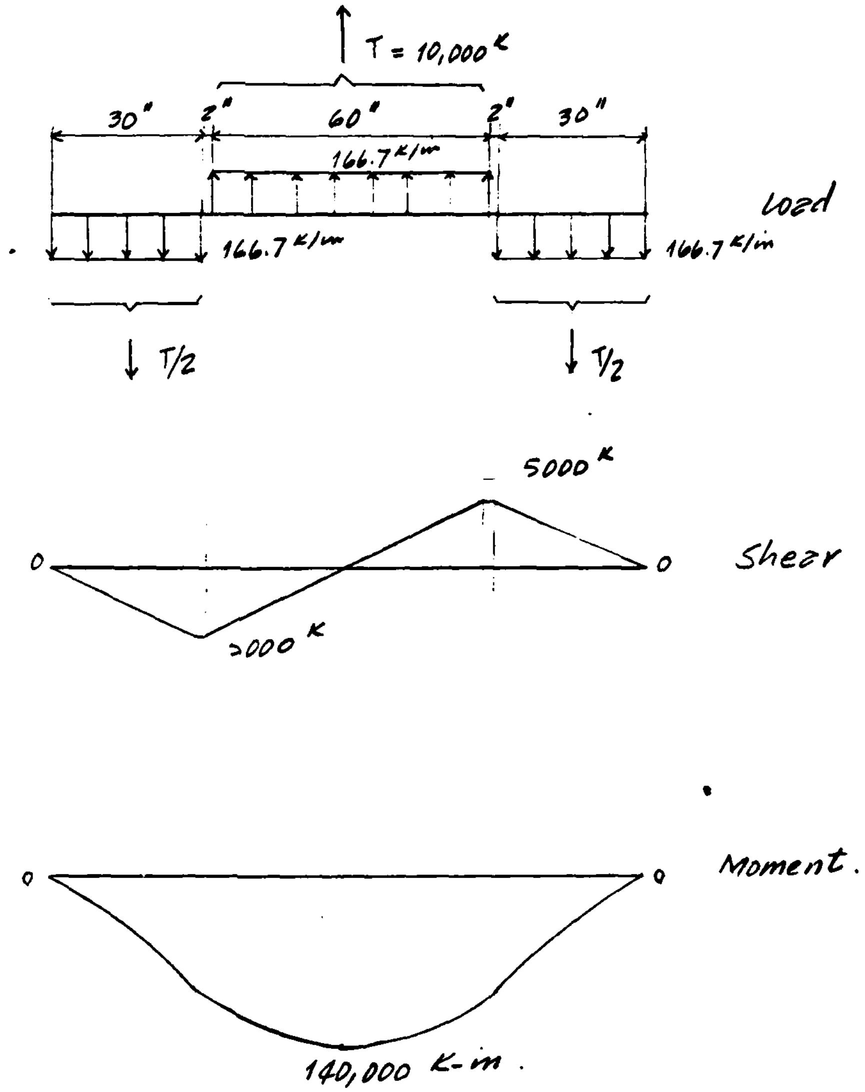
§ 1.7.1 B for steel pins

TYLIN INTERNATIONAL
STRUCTURAL ENGINEERING
315 Bay St., San Francisco, Ca. 94133

PROJECT:	ONR Navy Pier Concepts.
ITEM:	Finger / Spine conn.
DESIGN:	LINKS / hinge
DATE:	

SHEET: C-3
OF
REVISION:

Forces on pin.



Bending:

$F_b^* = 0.8\,F_Y = 80^{ksi}$ on extreme fibre

$$F_b = \frac{Mc}{I} = \frac{M}{\pi r^3/4}$$

$$r^3 = \frac{4M}{\pi F_b} = \frac{4 \times 140,000}{\pi \times 80} = 2228\ in^3 \quad \text{OR} \quad r = 13.06\ in$$

OR use $26\frac{1}{2}"\phi$ pin.

* Fatigue is not considered. Ultra-high strength steel can be used to keep a practicle pin diameter and appropriate stresses.

Shear:

$F_v = 0.4 F_y = 40^{ksi}$

$F_v = \dfrac{V}{A} = \dfrac{5000}{A}$ or $A = 125 \text{ in}^2$

or $d = \underline{12.6 \text{ in}}$

Bearing:

$F_b = 0.4 F_y$ for pins subject to rotation.

$F_b = \dfrac{P}{d\,W} = \dfrac{5000}{d \times 30} = 40^{ksi}$ or $\underline{d = 4.2 \text{ in}}$

Bending controls. use 26½"φ pin

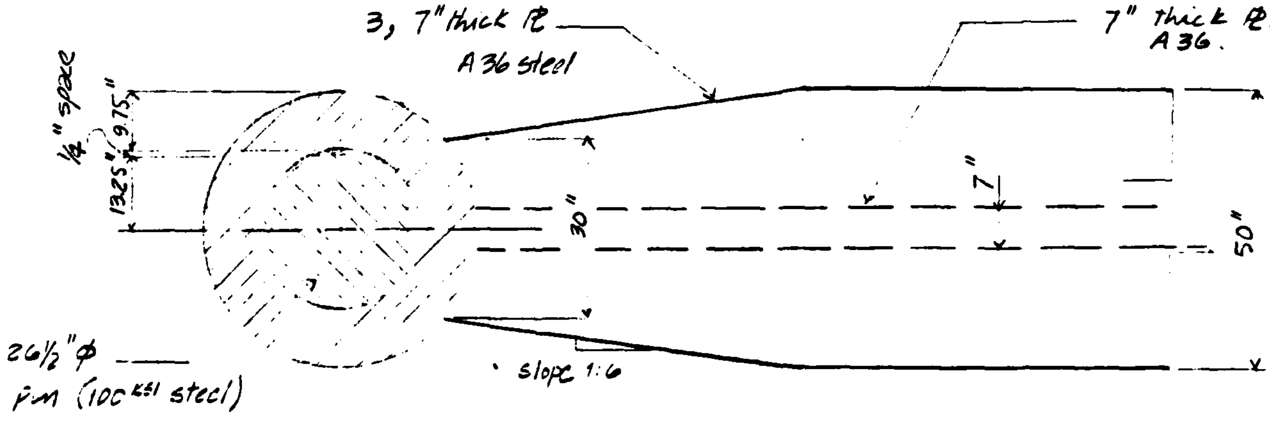
Check required thicknesses for hinge end tear-out based on allowable fatigue stress.

$F_v = 12^{ksi}$

$A_{req} = \dfrac{10{,}000}{12 \times 2} = 416.7 \text{ in}^2$

$t = \dfrac{416.7 \text{ in}^2}{60} = 6.9 \text{ in}$ use 9¾" as controlled by required net area.

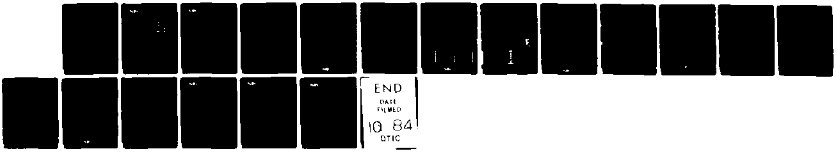
Horizontal hinge head details:

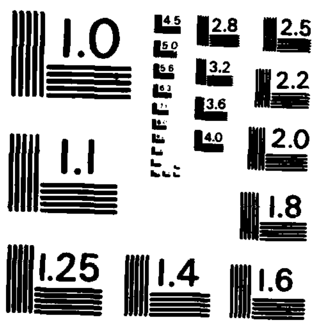


(see Fig 4(a) for details)

AD-A146 144   FINGER PIER/SPINE PIER CONNECTION FOR THE EXPEDITIONARY   2/2
PIER(U) LIN (T Y) INTERNATIONAL SAN FRANCISCO CA
APR 84 2/84 N00014-83-C-0869

UNCLASSIFIED   F/G 13/13   NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TYLIN INTERNATIONAL
STRUCTURAL ENGINEERING
315 Bay St., San Francisco, Ca. 94133

PROJECT: ONR Navy Pier Concepts
ITEM: Finger / Spine Conn.
DESIGN: Links
DATE:

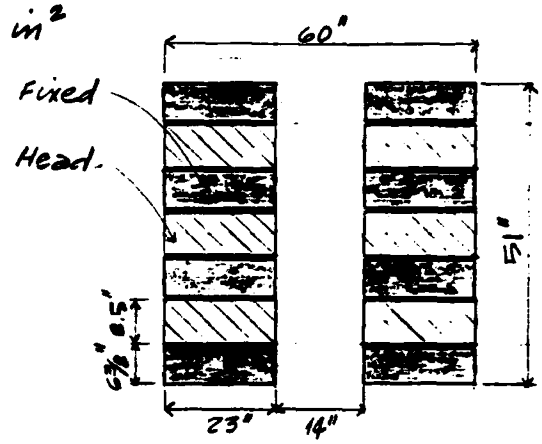
SHEET: C-5
OF
REVISION:

Vertical hinge :

Reqd. net area @ head = 1166 in^2

Area provided = $(8.5 \times 23)6$
= 1173 in^2
for head.

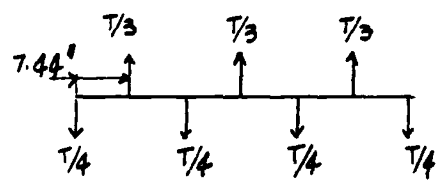
Area provided = $(6\tfrac{3}{8} \times 23)\,8$
= 1173 in^2
for fixed part.



Net area section
@ vertical hinge

Check pin diameter :

Bending:



Appx.

$M = T/3 \times 7.44''$

$M = 10{,}000/3 \times 7.44 = 24800^{k\text{-}''}$

$F_b = M / \pi r^3/4$ For F_y = 100 ksi ; $F_b = 0.8 F_y = 80^{ksi}$

$r^3 = \dfrac{4 \times 24800}{\pi \;\; 80} = 394.7\ in^3$ or $r = 7.3\ in$

$d = 14.6\ in \approx 14\ in$ O.K.

Shear:

$F_v = 0.4 F_y = 0.4 \times 100 = 40^{ksi}$

$F_v = \dfrac{V}{A} = \dfrac{10{,}000/4}{A}$

$A = 62.5\ in^2$ or $d = 8.9\ in < 14\ in$ OK

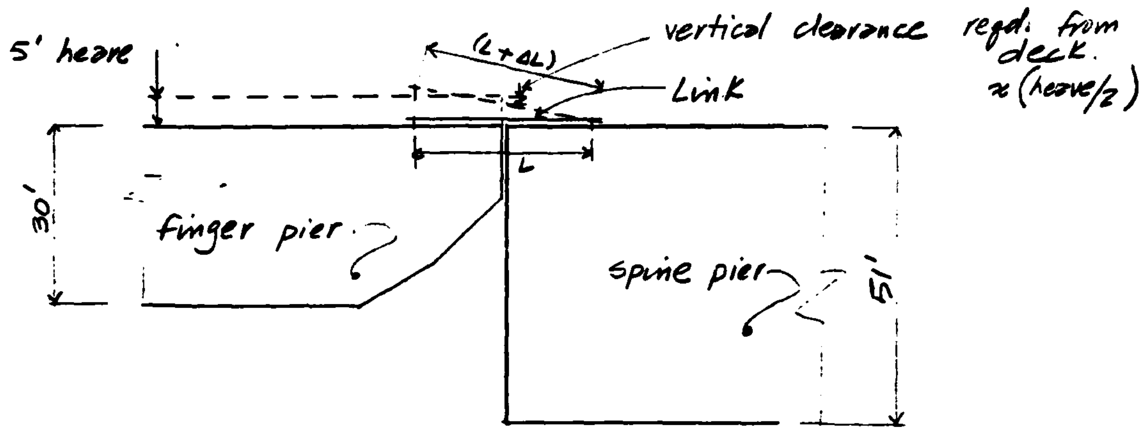
Bearing:

$F_b = \dfrac{10{,}000/3}{14 \times 8.5} = 28^{ksi} < 0.4 F_y$ for pins subject to rotation.

OK

TY/IN INTERNATIONAL
STRUCTURAL ENGINEERING
315 Bay St., San Francisco, Ca. 94133

PROJECT: ONR Navy Pier Concepts	SHEET: C-6
ITEM: Finger/Spine Conn.	OF
DESIGN: Link / Clearances	REVISION:
DATE:	



In order to allow unconstrained vertical motions of the finger & spine piers the links should be axially extendable.

A design value of 5' heave will be considered to estimate the required extension.

Total length of link = 30' = L

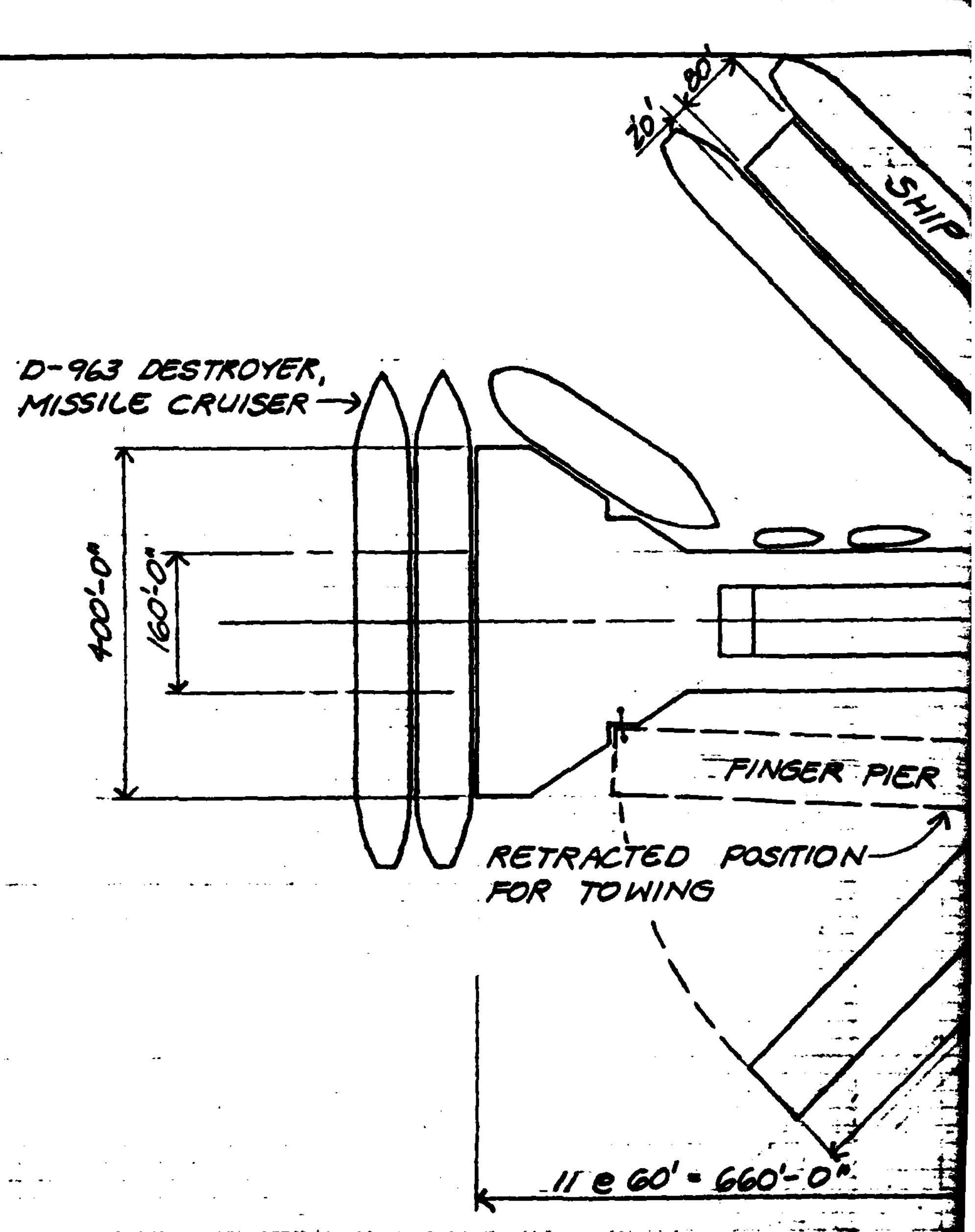
For 5' heave $\Delta L = (5^2 + 30^2)^{1/2} - 30 = 0.41'$
or ≈ <u>5 inches</u>

Appx. pitch angle = 0.0175 rad.
assume finger pier pivots @ 12' below deck level.
∴ displacement @ deck level ≈ 0.0175 × 12 = 0.21' or 2.5"

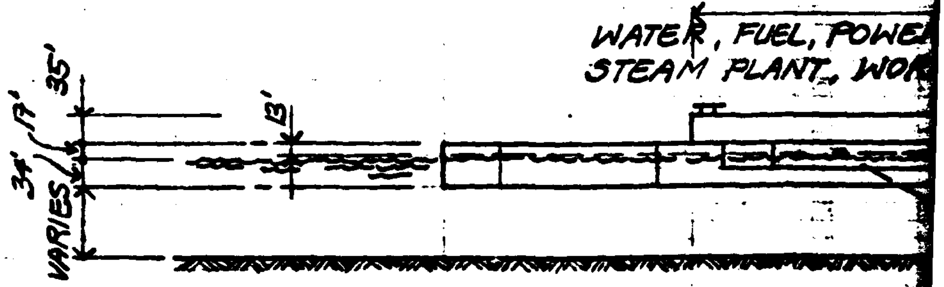
Total extension of link ≈ 7.5 in. say 12 in for design.

This can be provided by adding a hydraulic spring/damper to the link. The hydraulic spring can be manufactured for the desired requirements:
Stroke : 12" to 18"
Max. Force : 10,000 kips
Acceleration of loading ≈ 2.3 ft./s²
The compressive stiffness of the spring can be specified less than the tensile stiffness. This enables the the two piers to bear against each other without imposing high compressive forces in the links.

FIGURES



PLAN
1" = 200'-0"



PROFILE
1" = 200'-0"

DRAFTING

DESIGN

PROJECT No

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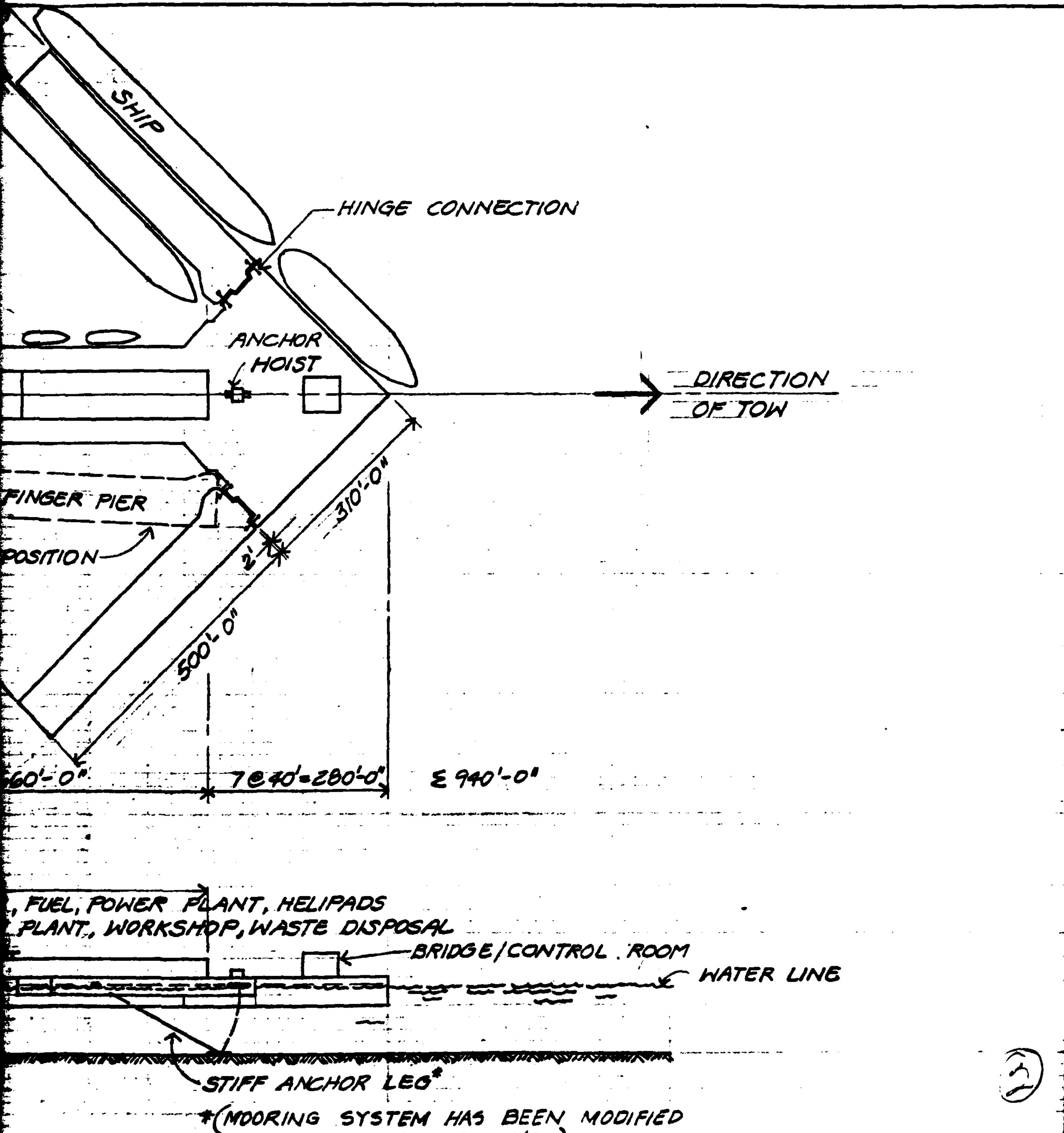


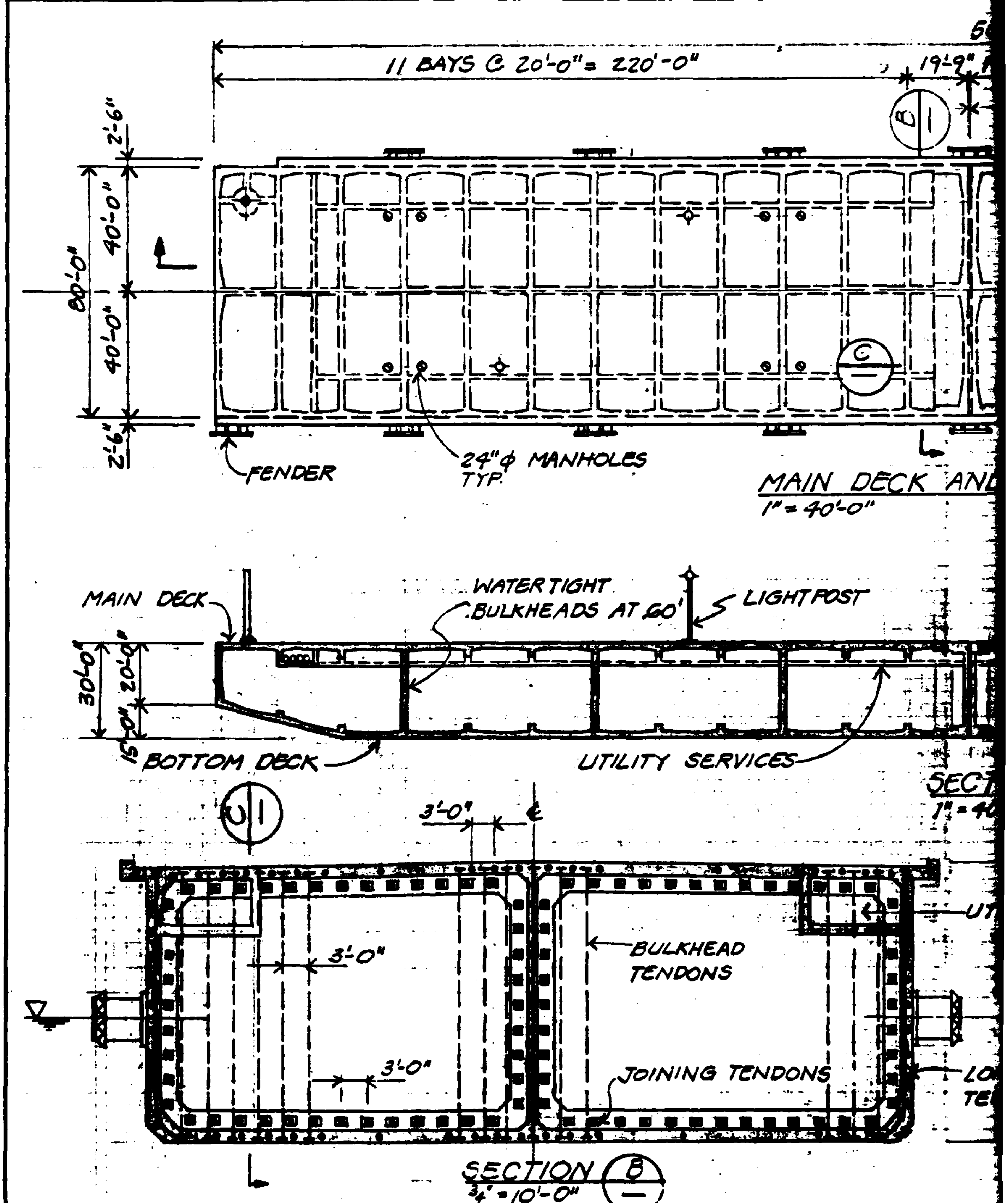
Nº	REVISION	DATE

Issued For	Date	By
	DEC 82	RM

SHEET TITLE: SCHEME A

PROJECT: EXPEDITIONARY PIER

SHEET Nº 1



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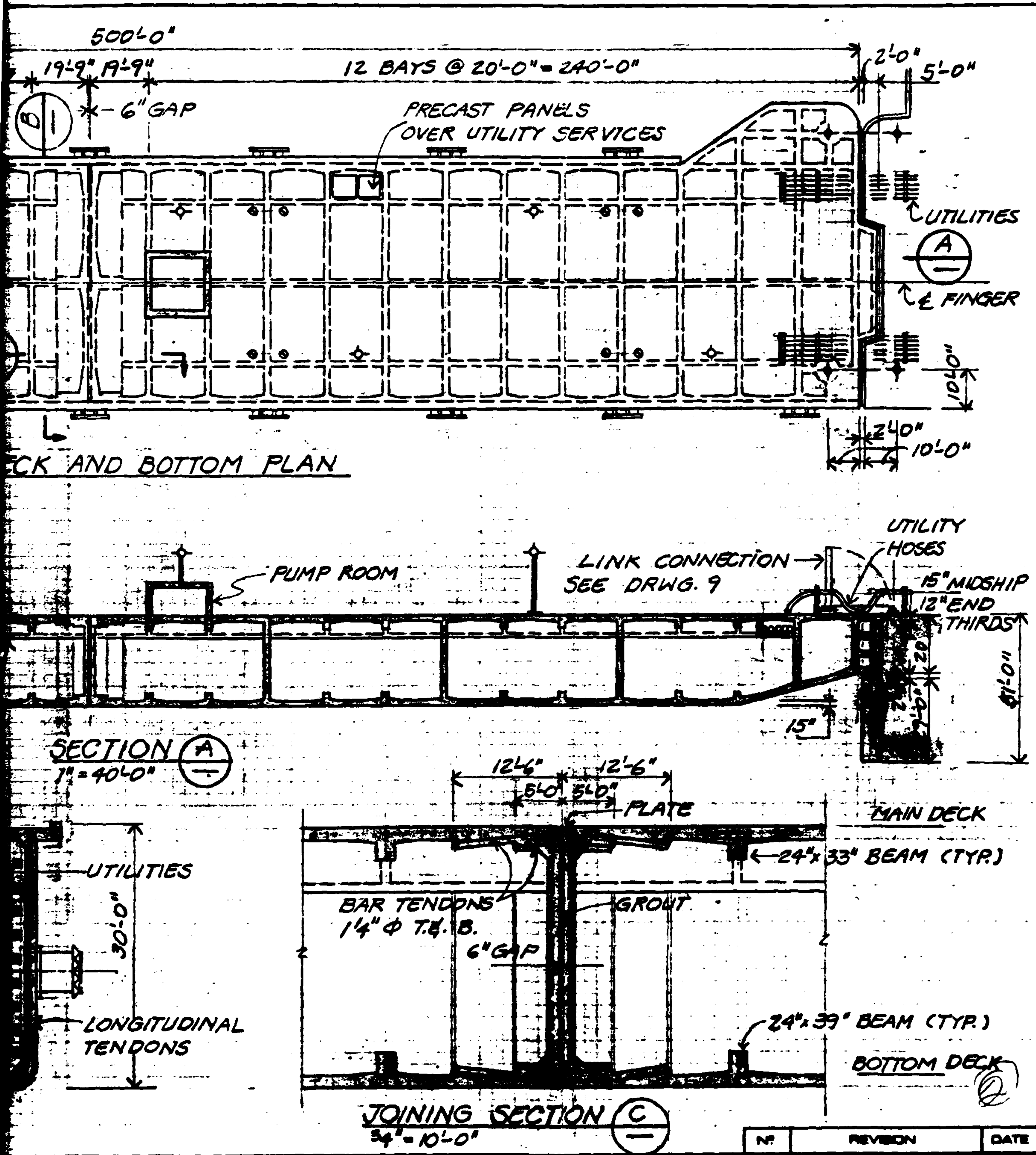


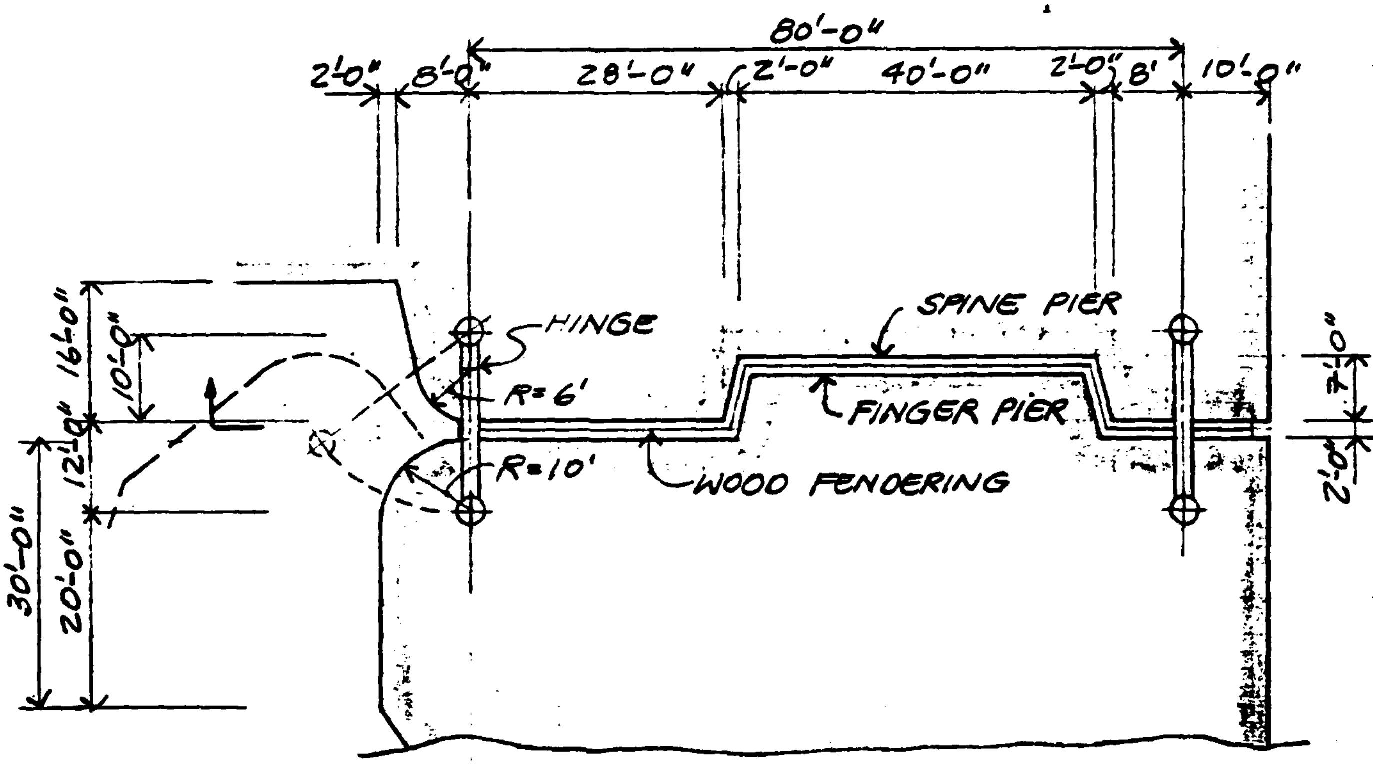
Nº	REVISION	DATE

...ed For	Date	By
	DEC. 82	RM

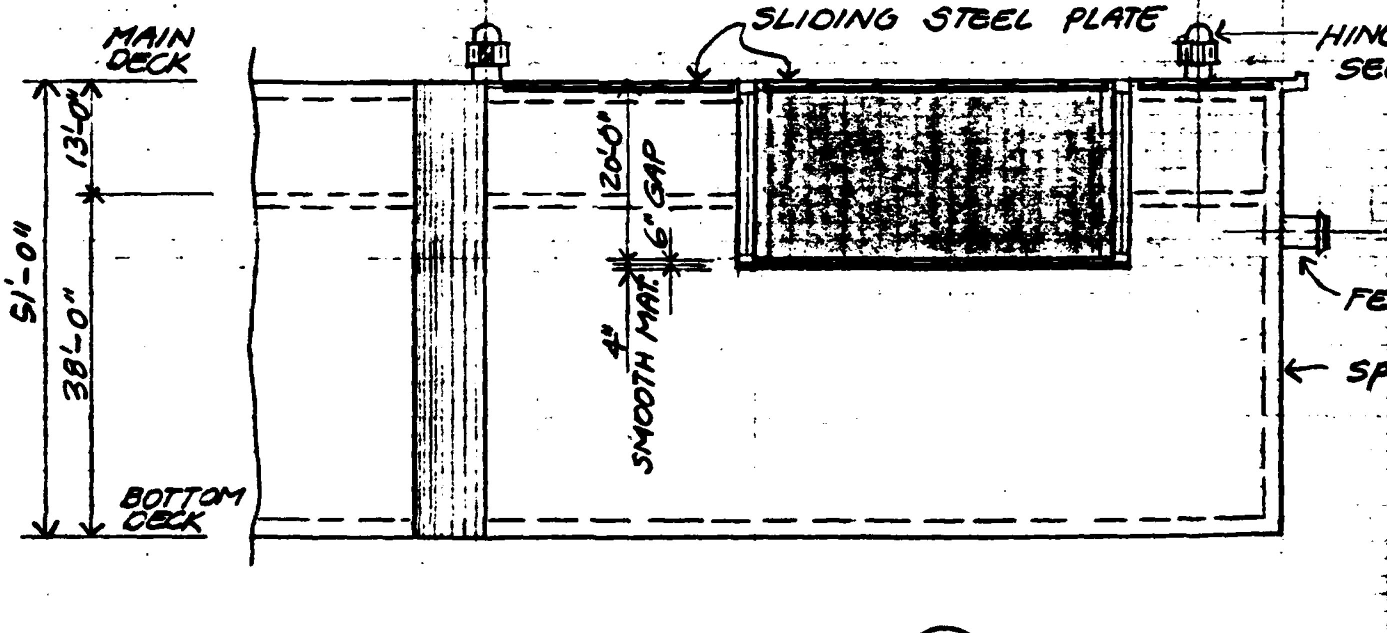
SHEET TITLE: FINGER PIER SECTIONS & DETAILS

PROJECT: EXPEDITIONARY PIER

SHEET Nº 2



PLAN



SECTION B
1" = 20'-0"

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PROJECT Nº

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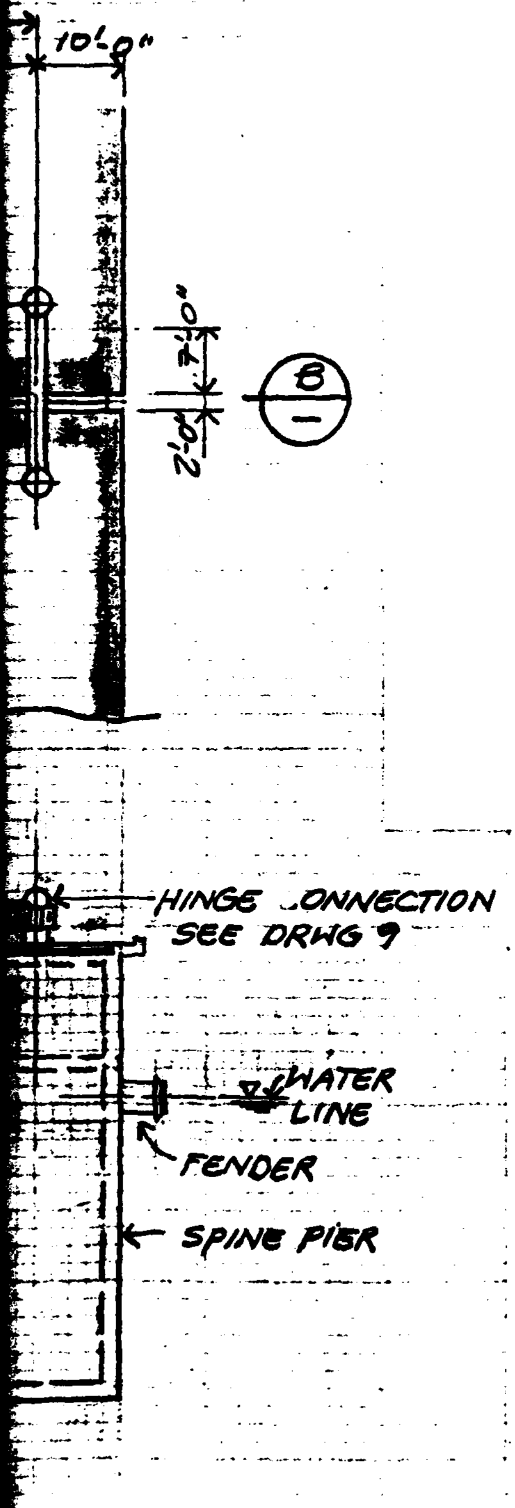


2

Nº	REVISION	DATE

Issued For	Date	By
	Jan. 83	RM

SHEET TITLE: SPINE PIER DETAILS

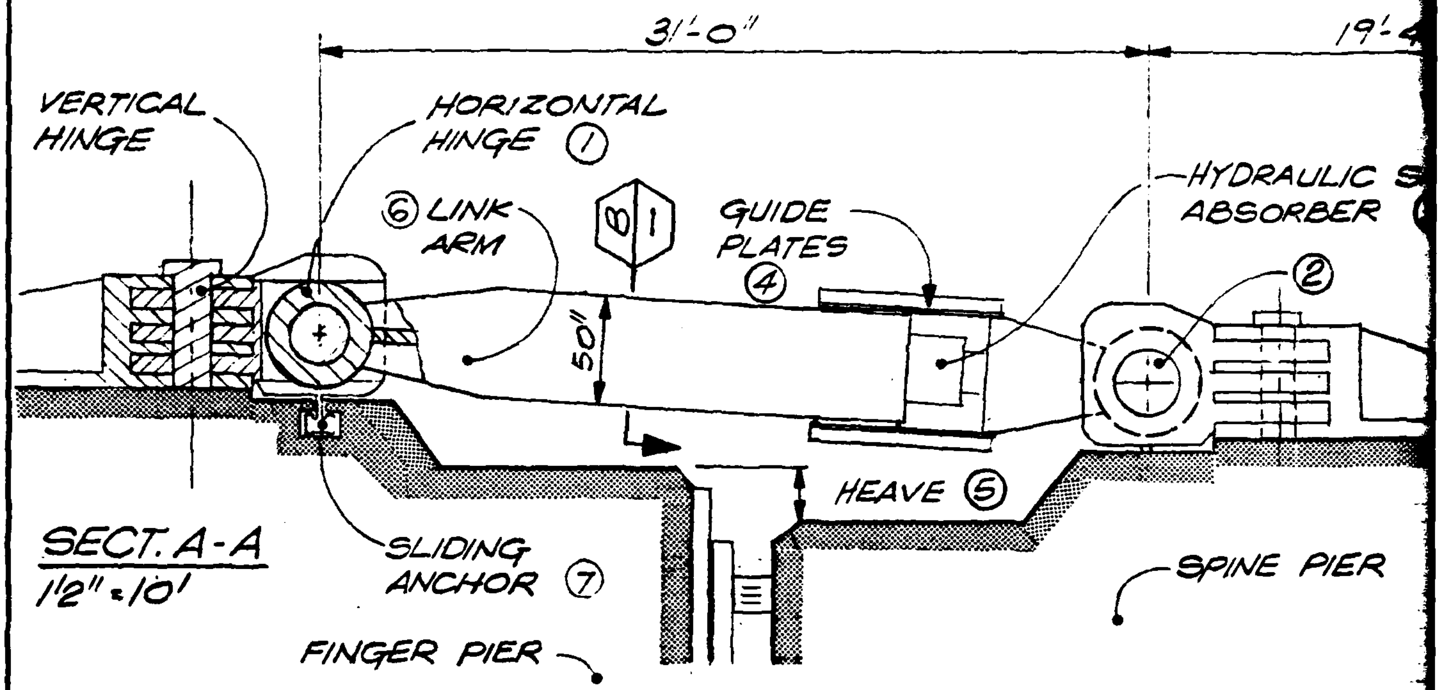
PROJECT: EXPEDITIONARY PIER

SHEET Nº 3

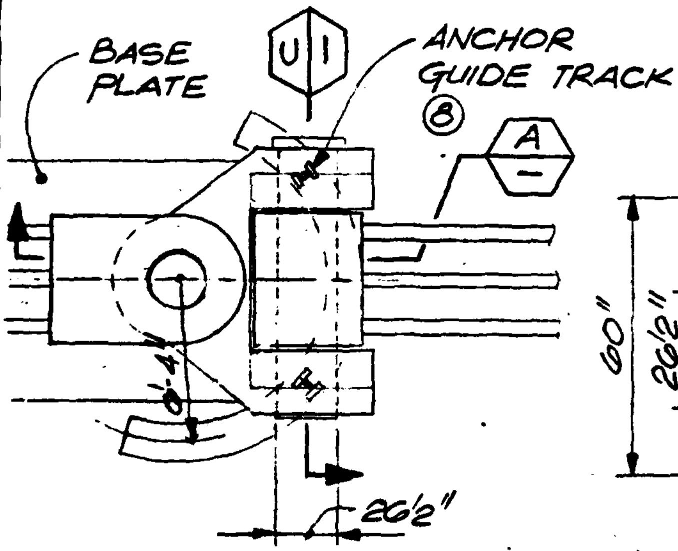
DRAFTING

DESIGN

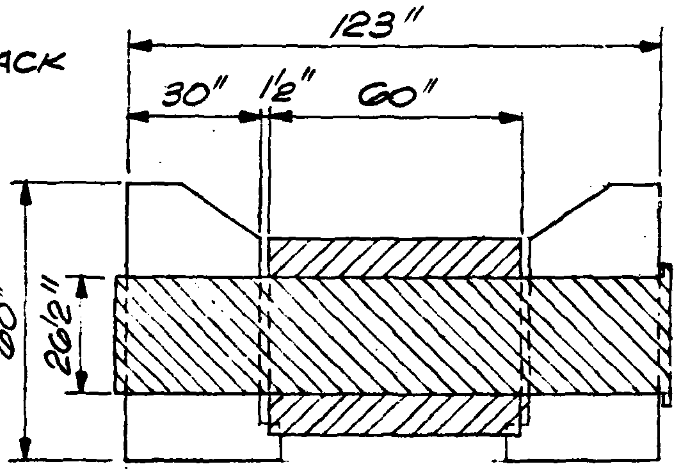
PROJECT Nº



ELEVATION
1/2" = 10'



TOP VIEW
1/2" = 10'



SECT. C-C
1" = 4"

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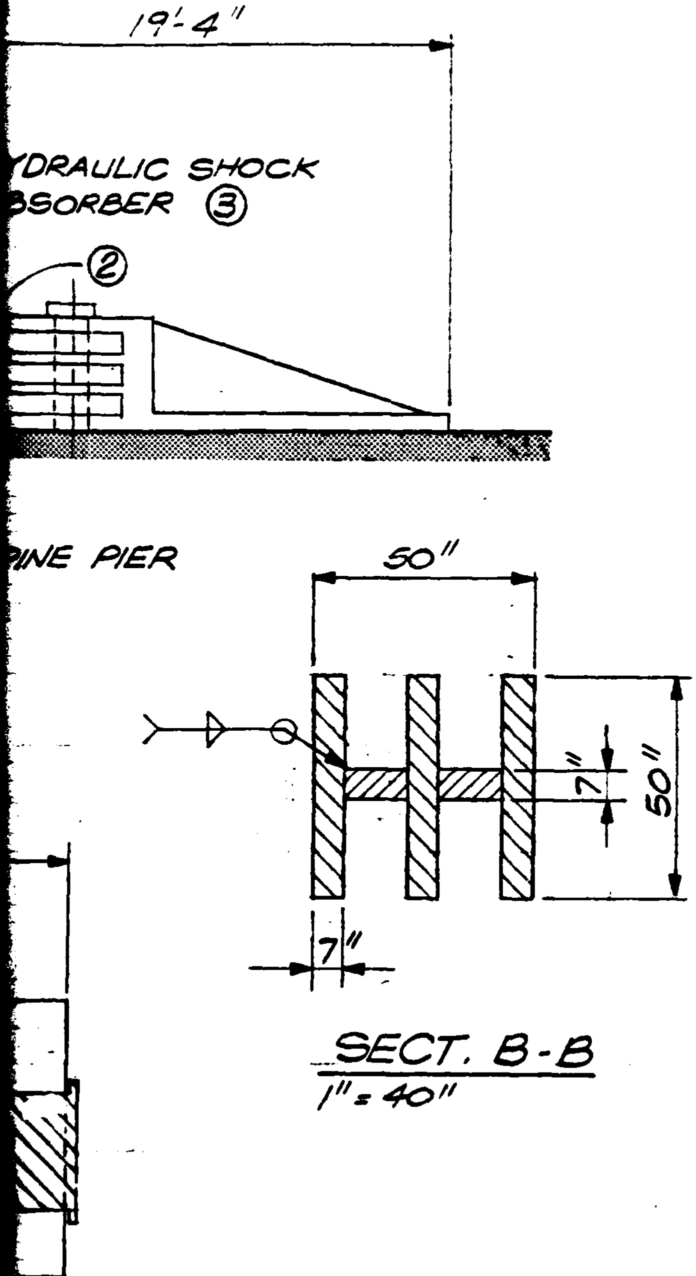


SECT. B-B
1" = 40"

NOTES

(1) COMPOSITE CENTERLEAF FOR EASY & QUICK ENGAGEMENT.

(2) HORIZONTAL HINGE @ SPINE PIER CAN HAVE "TOOTHED" CENTER LEAF TO REDUCE PIN SIZE.

(3) CYLINDER 32 IN. O.D., STROKE 12 IN. TO 18 IN. OR CLUSTER OF 2 SMALLER (22 IN. O.D.) SHOCK ABSORBERS CAN BE USED.

(4) GUIDE PLATES WITH STIFFENERS TO PREVENT MOMENTS DUE TO SELF WT. ON SHOCK ABSORBERS

(5) MAX. HEAVE OF UP TO 5 FT. IS EXPECTED DURING OPERATION.

(6) LINK ARM IS FLARED TO PROVIDE BETTER BULKING STABILITY FOR COMPRESSIVE LOADS. CAN BE DISENGAGED @ FINGER PIER HORIZONTAL HINGE AND STOWED @ THE SPINE PIER.

(7) SLIDING ANCHOR CONSTRAINS HORIZONTAL HINGE IN VERTICAL DIRECTION.

(8) ANCHOR GUIDE TRACK ALLOWS FREE ROTATION FOR VERTICAL HINGE.

(2)

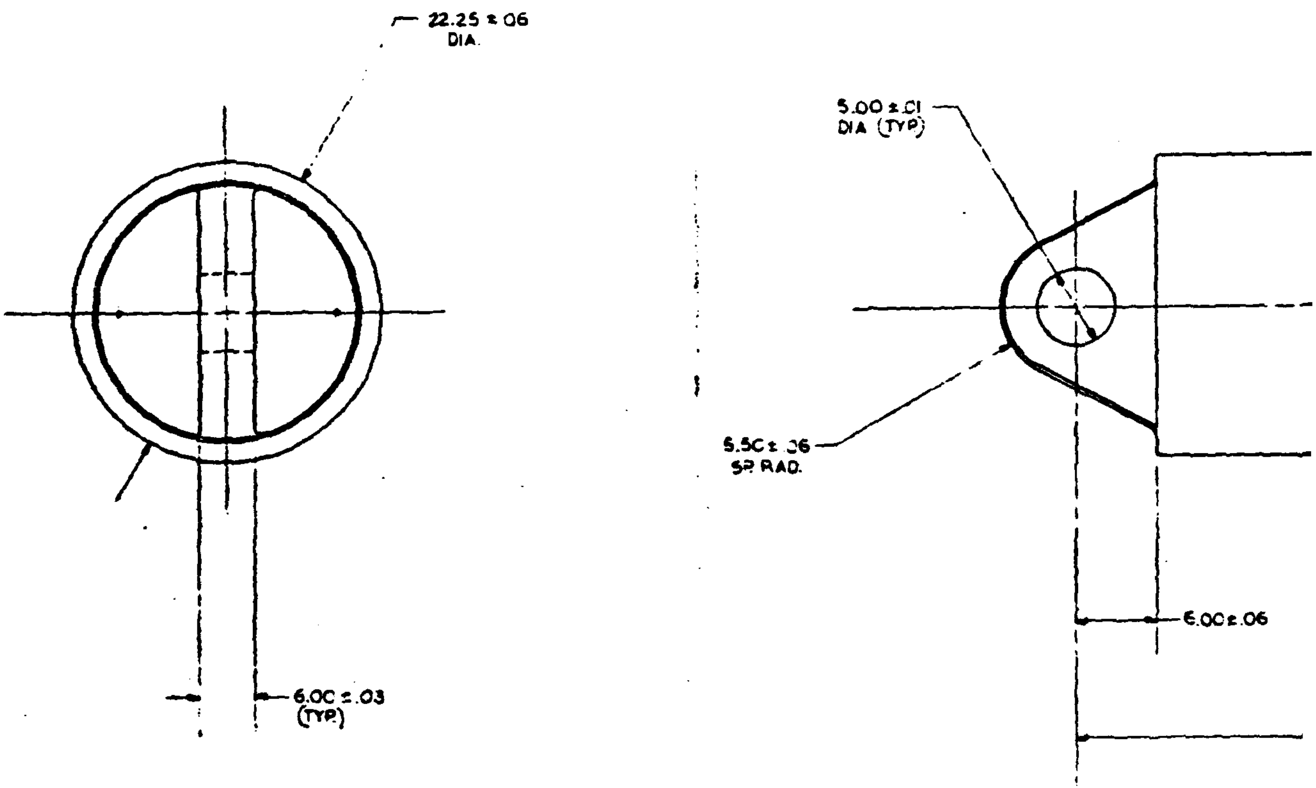
NO.	REVISION	DATE

...ued For	Date	By

SHEET TITLE: **EXTENDABLE LINK**

PROJECT: **FINGER/SPINE CONNECTION**

SHEET NO. **4 a**



SPECIFICATIONS:

1) DAMPING OUTPUT IN EXTENSION MODE TO BE 3000000 LB. (REF) AT 36 IN/SEC (NOM) VELOCITY.

2) NO APPRECIABLE DAMPING OUTPUT IN COMPRESSION MODE

3) DAMPING OUTPUT IN EXTENSION MODE TO BE INDEPENDANT OF STROKE POSITION AND TO VARY WITH THE IMPACT VELOCITY RAISED TO THE .70 (REF) POWER.

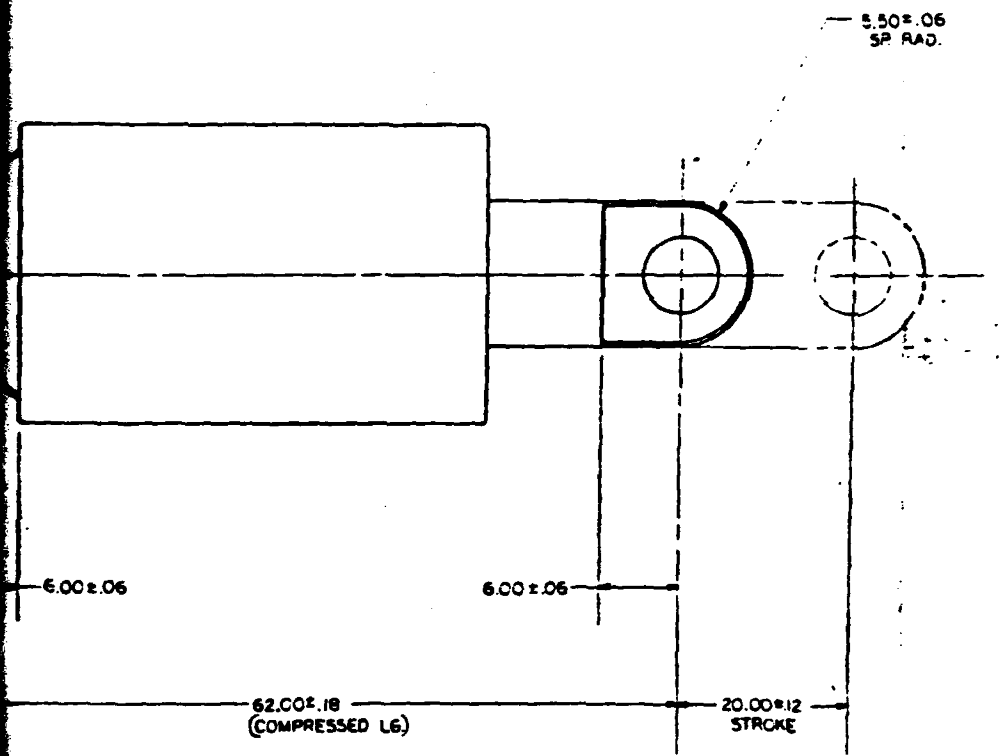
4) UNIT EXTENSION STROKE = 20.00 IN (NOM)

5) INTERNAL COIL SPRING RESET SYSTEM

6) TWO UNITS TO BE USED IN PARALLEL PER SYSTEM.

(1)

ZONE	LTR	DESCRIPTION	DATE	APPROVED



MAR 21 1984

CONTRACT NO

MATERIAL
CORROSION RESISTANT
MATERIALS

T.Y. LIN. INTERNATIONAL
SHOCK ABSORBER

CODE IDENT NO. 08742 DRAWING NO. 6TT-13038-01 4 b

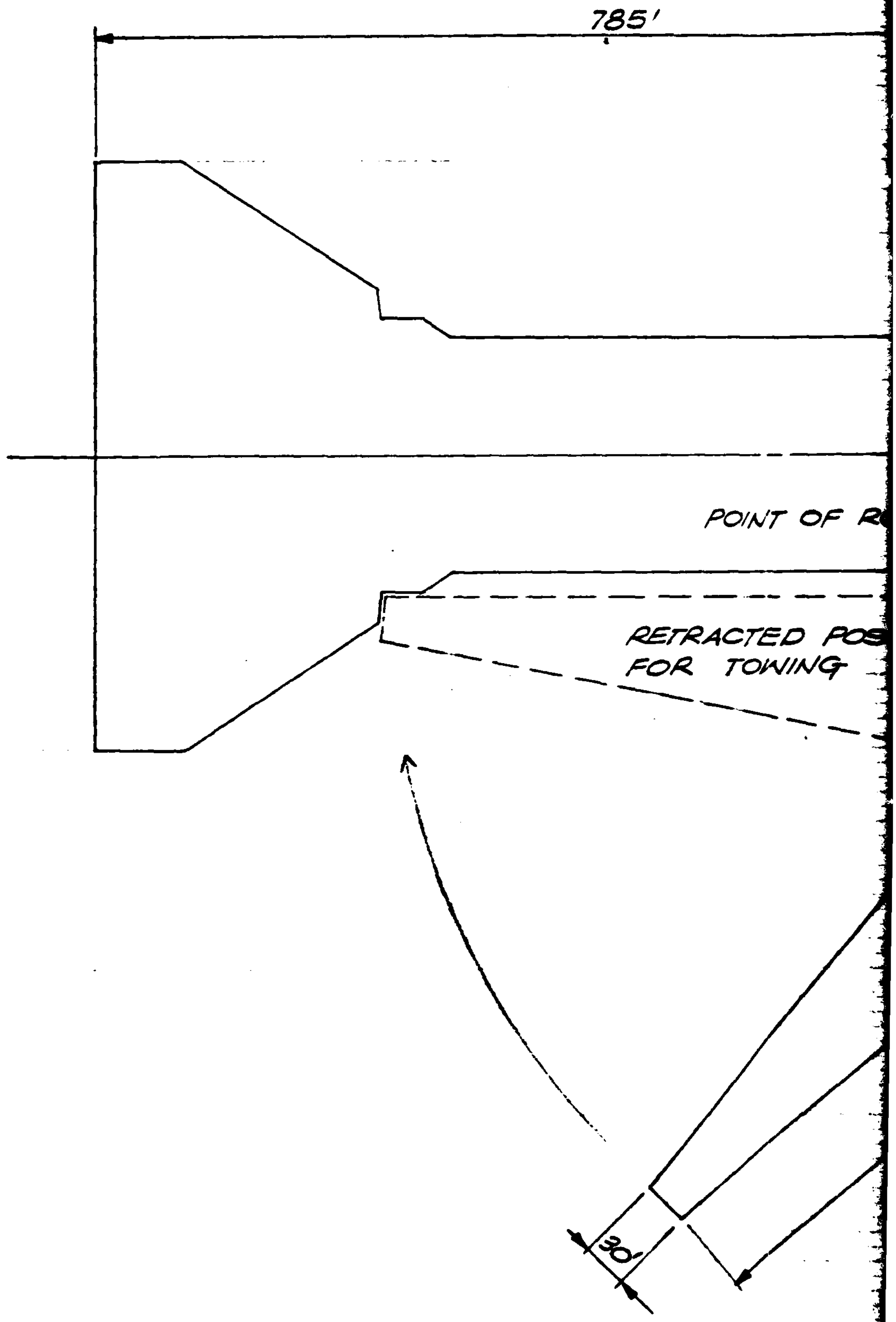
SCALE NTS SHEET 1 OF 1

NEXT ASS'Y | USED ON
APPLICATION

DRAFTING

DESIGN

PROJECT Nº



7

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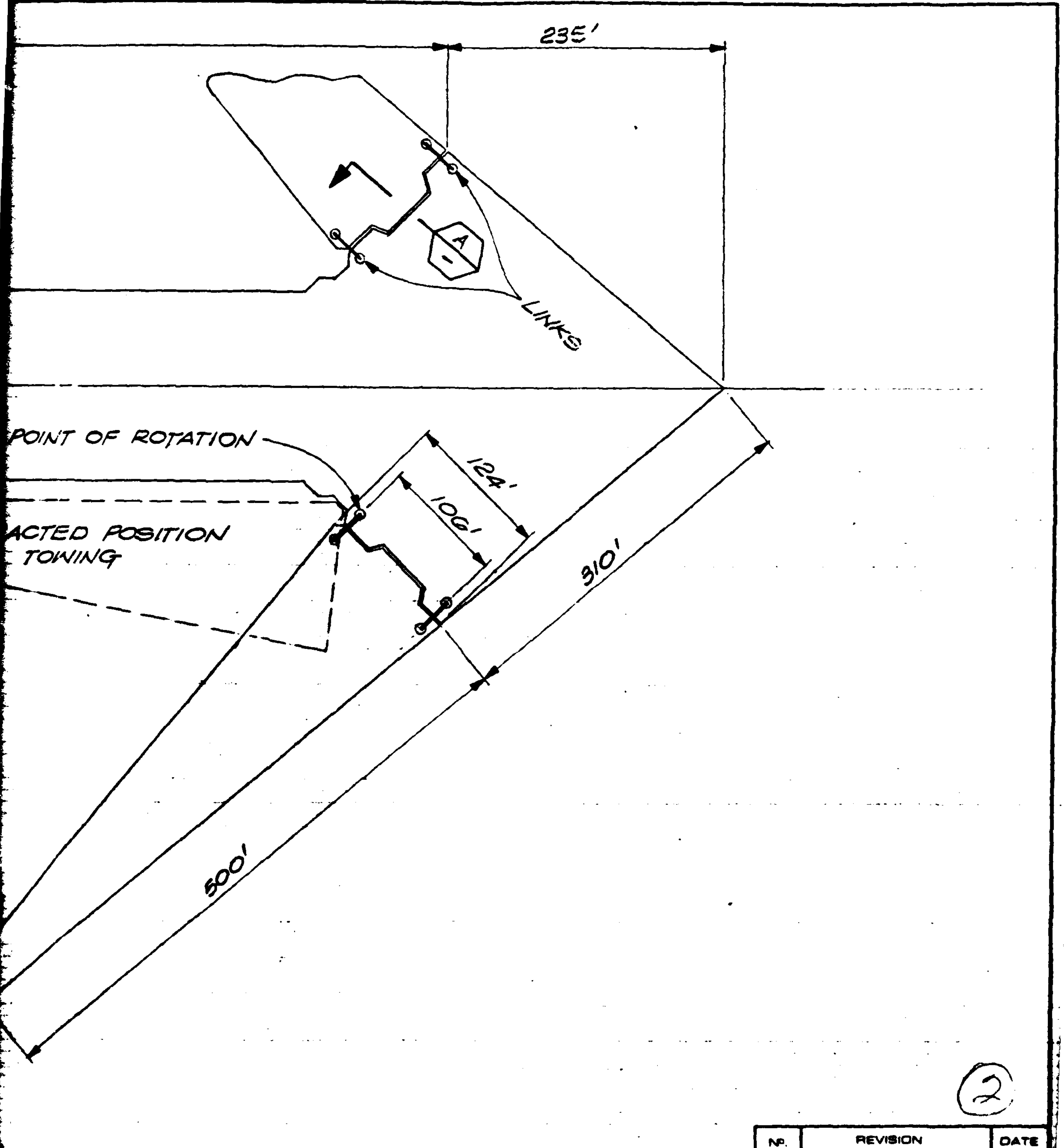
315 Bay St., San Francisco, Ca. 94133 Tel.(415)982-1050

Issued For



NO.	REVISION	DATE

...ued For	Date	By

SHEET TITLE: **REVISED FINGER PIER CONFIGURATION**

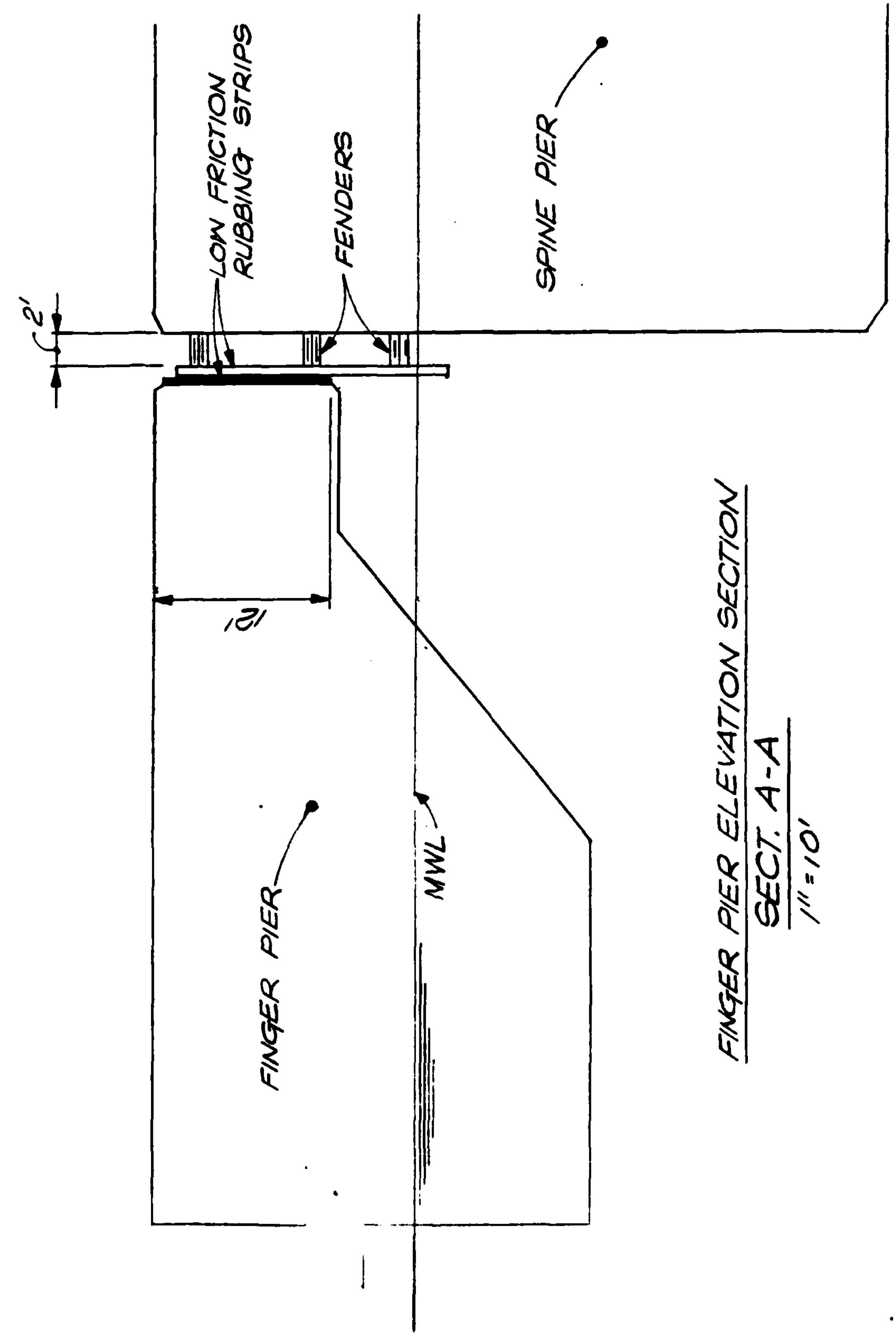
PROJECT: **FINGER/SPINE CONNECTION**

SHEET NO. **5**

TY LIN INTERNATIONAL
STRUCTURAL ENGINEERING
315 Bay St., San Francisco, Ca. 94133

PROJECT:	NAVY PIER CONCEPTS
ITEM:	FINGER/SPINE PIER CONN.
DESIGN:	FINGER PIER ELEV. SEC.
DATE:	

SHEET: FIG. 6
OF
REVISION:

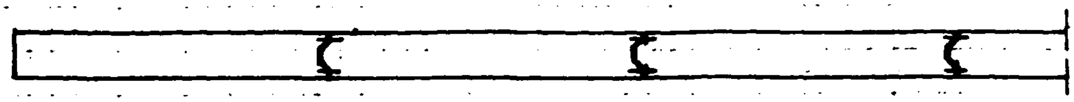


FINGER PIER ELEVATION SECTION
SECT. A-A
1" = 10'

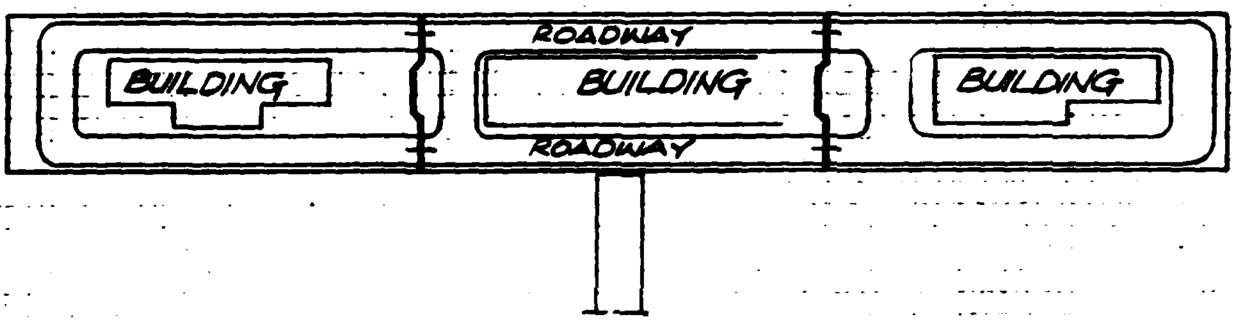
TYIN INTERNATIONAL
STRUCTURAL ENGINEERING
315 Bay St., San Francisco, Ca. 94133

PROJECT:	NAVY PIER CONCEPTS
ITEM:	FINGER/SPINE PIER CONN.
DESIGN:	APPLICATIONS OF
DATE:	RETRACTABLE PIER

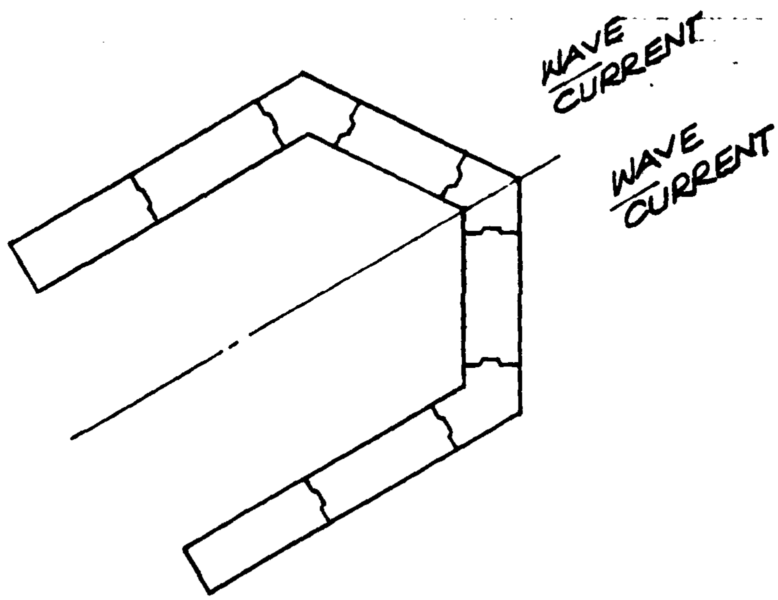
SHEET: FIG. 7
OF
REVISIONS



(1) FLOATING ROADWAY TO OFFSHORE INSTALLATIONS



(2) FLOATING PLATFORM FOR OFFSHORE INSTALLATIONS



(3) FLOATING BREAKWATER FOR OFFSHORE HABOR

SOME OTHER APPLICATIONS OF RETRACTABLE PIER

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PROJECT:	NAVY PIER CONCEPTS
ITEM:	FINGER/SPINE PIER CONN.
DESIGN:	EFFECT OF INCREASED LINK
DATE:	DISTANCE

SHEET: FIG. 8
OF
REVISION: